SECTION 5.3: WATER RIGHTS AND WATER USE

Table of Contents

List of Figures

List of Tables

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GLOSSARY

Accretion Flow: Flow gained by a river between two points.

Acre-ft: Acre-feet – volume of water that covers one acre of land in one foot of water, equivalent to 325,850 gallons.

ADD: Average Day Demand as defined by the Washington Department of Health in the Design Manual (1999).

Allocation: the designation of specific amounts of the water resource for specific beneficial uses.

Annual Volume Limitation: Maximum volume of water per year allowed under a water right.

Application: Here the term refers to a request submitted to obtain a water right certificate from the Department of Ecology.

Beneficial Uses: Uses of water for domestic, stock watering, industrial, commercial, agricultural, irrigation, hydroelectric power production, mining, fish and wildlife maintenance and enhancement, recreational, and thermal power production purposes, and preservation of environmental and aesthetic values and all other uses compatible with the enjoyment of the public waters of the state.

Certificate: See Water Right Certificate.

cfs: cubic feet per second – units assigned to the volume of water that flows past a fixed point in a river channel every second; discharge or rate of flow; equivalent to 449 gallons per minute (gpm).

Claim: See Water Right Claim.

Consumptive Use: Use of water that is fully used and does not result in any flow returning to the ground or surface water system; consumptive use of water results in a diminishment of the water source primarily due to evapotranspiration.

CWRIS: Certificate Water Right Information System - Water right certificate issued from Department of Ecology and identified under the old system of WRIS (Water Right Information System). Follows the control number of the water right.

Depletion: Here the term refers to a reduction in or diminishment of streamflow

DS: Domestic Single – purpose code for domestic single beneficial use of water.

DU - dwelling unit.

Effective Precipitation: The part of rainfall that can be used to meet the evapotranspiration of growing crops. This does not include surface runoff or percolation below the root zone.

ENSO: El Niño Southern Oscillation. Changes in temperature of the oceanic and atmospheric system in the tropical Pacific having important consequences for weather around the globe. Typical temperature fluctuations occur every 2 to 7 years.

Exceedence Flows: Percentage of flows within a given time series that equal or exceed a specific value within a particular reach of stream or river.

Exempt Well: A well from which ground water is withdrawn and used without an explicit water right, usually for domestic use but also can include non-commercial irrigation of up to ½ acre or an industrial use.

gcd: Gallons per capita per day – volume of water use per person per day.

gpm: Gallons per minute – volume of withdrawal equivalent to .0022 cubic feet per second.

IFIM: Instream Flow Incremental Methodology Assessment – A method used to determine fish habitat needs according to cross sections, profiles, and flow rates.

Instantaneous Diversion Rate: Maximum rate of diversion at one point in time as specified under a given water right by Washington Department of Ecology.

IR: Irrigation – purpose code for irrigation as a beneficial use assigned to a water right.

Land Segment: A land segment is a subdivision of the watershed, consisting of an area or areas with homogeneous hydrologic characteristics, such as mean annual precipitation, soils and vegetation cover. Land segments are represented by a set of parameters. Some of these parameters can be determined from known watershed characteristics, either by measurement or by estimation. Other parameters must be determined by calibration, that is, by fitting computed hydrographs to the observed hydrographs.

MDD: Maximum Day Demand which is estimated at 2 times the Average Day Demand (ADD) according to the Washington Department of Health, Water System Design Manual (1999).

Miscellaneous Measurements: A single measurement of streamflow at a particular point and time in a watershed; these measurements are typically in addition to streamflow measurements at a continuously recording gaging station.

Natural flow: Streamflow values as they would have occurred in a state of nature, preceding any human influences that might alter the flow including diversions from a river or changes in land use/land cover.

On-farm Efficiency: Percentage of applied water that is potentially accessible to crop evapotranspiration.

PDO: Pacific Decadal Oscillation – changes in temperature of the oceanic and atmospheric system in the north Pacific having important consequences for weather around the globe. Typical temperature fluctuations occur every 20 to 30 years.

Permit: See Water Right Permit.

POD: Point of Diversion – location where surface water or ground water is diverted or withdrawn for use as allocated under a water right.

POU: Place of use – the area of land where water is used as legally described on the water right document.

PWS: Public Water System – purveyor of water within a specified service area.

Reach: A segment of a stream channel. Simulation of the flow in the rivers is done by dividing the stream channel network into a number of reaches. A reach is represented by an element situated between two points. The cross section, slope and roughness within a reach are constant. Channel reach parameters represent the physical characteristics of each reach.

Return Flow: Water withdrawn or diverted that is not used consumptively and thereby returns to the river via surface or subsurface pathways.

Shapefile: Electronic ArcView (Geographic Information System) file format for storing geographic features and attributes

ST: Stock Watering – a beneficial use for a water right that is intended to provide water to sustain farm animals.

TNC: Transient Non-Community water system such as a public rest area or a restaurant etc.

Water Right Certificate: A water right certificate is issued by the Department of Ecology to certify that water users have the authority to use a specific amount of water under certain conditions. These conditions are based on beneficial use of water under the water right permit. The water right certificate is a legal document recorded at the county auditor's office. The certificate completes the process of obtaining a

water right. Once a certificate is issued, no expansion is allowed under the water right.

Water Right Claim: A water right claim is a statement of claim to a water use that began before the State Water Codes were adopted and is not covered by a permit or certificate. A claim may represent a valid water right if it describes a surface water use that began before 1917 or a ground water use that began before 1945, a water right claim that was filed with the state during an open filing period designated under RCW 90.14 (the Water Rights Claim Registration Act), or is covered by the ground water exemption.

Water Right Permit: A water right permit is permission given to water right applicants by the state to develop a water right. Water rights are developed when water right applicants follow the provisions outlined in their permit, using water for the purposes and up to the limits stated in the permit. Water right permits remain in effect until the water right certificate is issued, if all terms of the permit are met, or the permit has been canceled.

WDOH: Washington Department of Health.

WRATS: Department of Ecology Water Rights Tracking System containing information describing water right certificates, permits, applications and water right claims.

WRIA: Water Resources Inventory Area.

WSU: Washington State University.

SECTION 5.3: WATER RIGHTS AND WATER USE

INTRODUCTION

The water rights and water use sections are intended to provide the Nisqually Planning Unit with initial information to better understand the water quantity picture in the Lower Nisqually Basin of WRIA 11. The primary information includes the amount of water allocated under the water rights awarded by the State of Washington and an estimate of the actual water being used in each subbasin, to the extent possible.

The primary effort for the water rights analysis focused on summarizing water rights by type of use, type of document and type of source for each subbasin and for the Lower Nisqually. The Washington Department of Ecology (WDOE) is the state agency in charge of administering water rights. WDOE has developed a database, called Water Rights Allocation and Tracking System (WRATS), summarizing the water rights in each Water Resources Inventory Area (WRIA) and was obtained in Microsoft Access Database format. The water rights represent the major portion of the allocated water, however, exempt ground water withdrawals (or exempt wells) are also legal entitlements to the use of water. Accounting for these exempt wells is a more difficult process since no tabulation of these wells is available. A rough estimate was attempted using water rights information and existing population and public water system data.

Data quality and availability limited the analysis; however, the summary of both water rights and water use will provide a basis for the planning unit to determine the levels of effort for the next phase of work in each subbasin. The water rights and estimates of actual use were compared to the stream flows developed in Chapter 5, Section 5.2.

This section is organized so that the methods and approach are discussed along with summaries of the entire Lower Nisqually River Basin (lower portion of WRIA 11) followed by a brief discussion of each subbasin. Numerous tables and graphs have been developed to summarize the data in various ways for a better understanding of the water quantity situation in each subbasin and in the entire WRIA 11 below Alder Dam. The subbasin sections contain primarily graphs and tables for informational purposes; an in-depth analysis of each subbasin was beyond the scope of this Level 1 Assessment.

WATER RIGHTS

There are four different types of water rights that are referred to in this document: applications, permits, certificates, and claims. A definition of each is presented here to provide the necessary background to understand the terms in this report. Most of the information provided here is taken directly from WDOE's website:

(http://www.ecy.wa.gov/programs/wr/wrhome.html).

- An *Application* is a request submitted to obtain a water right certificate from the Department of Ecology.

- A *Permit* is permission given to water right applicants by the state to develop a water right. Water rights are developed when water right applicants follow the provisions outlined in their permit, using water for the purposes and up to the limits stated in the permit. Water right permits remain in effect until the water right certificate is issued, if all terms of the permit are met, or the permit has been canceled.

- A *Certificate* is issued by the Department of Ecology to certify that water users have the authority to use a specific amount of water under certain conditions. These conditions are based on beneficial use of water under the water right permit. The water right certificate is a legal document recorded at the county auditor's office. The certificate completes the process of obtaining a water right. Once a certificate is issued, no expansion is allowed under the water right.

- A *Claim* is a statement of claim to a water use that began before the State Water Codes were adopted and is not covered by a permit or certificate. A claim may represent a valid water right if it describes a surface water use that began before 1917 or a ground water use that began before 1945, a water right claim that was filed with the state during an open filing period designated under RCW 90.14 (the Water Rights Claim Registration Act), or is covered by the ground water exemption.

METHODS

The WRATS database was obtained from WDOE in March 2001. WDOE assigns the location of the point of diversion (POD) of each water right in the database by using the nearest quarter-quarter (Q/4-Q/4) section of the actual POD legal description; the legal

description of the point of diversion is not in the database but is on the original document (certificate, permit, or application). Due to the limited scope of this level of analysis, the WRATS database locations were used to plot the point of diversion (POD) for each water right on file with WDOE.

The PODs were placed at the centroid of the quarter-quarter section for each right as noted in the water source table of the WRIA 11 WRATS database. The largest distance from the centroid to any point in the same quarter-quarter section is about 1900 feet, therefore, a buffer of 2000 feet was used to identify whether rights were within the basin boundary or outside of it. Rejected, relinquished, or cancelled rights were deleted from the analysis.

The WRATS database included numerous duplicate entries that identified multiple points of diversion and/or points of use for the same water right document number. In addition, there were many *change* documents. Changes to water rights could include a change in use, additional points of diversion/withdrawal, change in point of diversion, change in source type (i.e. surface to ground) and/or a change in the place of use. Under state law, a water user is required to file a change application for any of these alterations to a water right.

The duplicates were not counted in the overall summary of water rights, however, the number of *changes* to rights were noted in the summary table, but not added to the total numbers, either in allocated amounts or number of rights. While the change to a right is in the database, it is not noted what the change entails; the entry in the database does note if the change has been issued.

A water right can have more than one beneficial use and while these are listed in the database, the amount allocated for each of these uses is not noted. The assumption was made that the initial beneficial use listed was the primary beneficial use and thus, water rights were summarized accordingly.

Many anomalies have been noted using the WRATS database. For example, there were rights in the WRIA 11 database that once plotted in accordance with their specified location were in a different WRIA. This would lead one to believe that there are also rights located in other WRIAs that actually belong in WRIA 11. In addition, from other western Washington projects, some water rights found on paper were not found in WRATS for that WRIA.

Certain fields in the WRATS tables have been found blank, such as allocated amounts and locations. Because of the missing data and the inexact nature of identifying the location of water right diversions/withdrawals based on the Q/4-Q/4 section, the information provided in this section is preliminary in nature and intended to provide a general understanding of the water allocation within each subbasin. A more detailed analysis of the WRIA 11 data would be required to determine the extent of the errors and anomalies for Lower Nisqually River Basin.

ASSUMPTIONS

Assumptions used in the water rights summaries include:

- When summarizing the water rights, the first listed beneficial use for each right was assumed to be the primary use for that right.

- Certificates and permits with priority dates before 1965 were routinely not assigned annual volume limitation. In other instances, these data were simply missing from the water rights database. For single domestic rights, a brief analysis was conducted to determine any pattern to the annual volume limitation over time. Prior to 1985, the majority of the single domestic rights were allocated 1 acre-foot; from 1985 on, about 76% of the rights were allocated either 0.25 acre-foot, 0.33 acre-foot, or 0.5 acre-foot. According to Buck Smith at WDOE, allocations since 1992 have mostly been 0.33 acre-feet. In the Lower Nisqually Basin, all rights after 1990 had an associated volume limit of 0.33 acre-feet, therefore, this date was used for this basin. To provide realistic summaries of annual volumes allocated the following assumptions were made to fill in the missing data:

    - Single domestic rights were assigned 1 acre-foot for priority dates preceding 1985; 0.5 acre-foot was assigned to rights with a priority date from 1985 –1990; and, 0.33 acre-foot for 1991- 1999 rights.

    - Municipal and commercial rights were assigned the full conversion from cfs to acre-feet, i.e. 25 cfs municipal right was assumed to divert full-time year round (18,100 af). City of Olympia's water rights were the only municipal rights that were not assigned volume limits. As per Doug Micheau, City of Olympia Assistant Director of Utilities, the right was assumed to be diverted full-time year round.

- Irrigation rights were assigned 2 acre-feet per acre, allowing for the crop with the highest demand of irrigation water, pasture grass.

- Multiple domestic rights with missing data were few and WDOE was contacted to provide annual volume limits to fill in these missing data.

- Fisheries, wildlife, power, recreation, and beautification rights were assumed non-consumptive rights.

- Applications for new water rights, while contained in the WRATS database, have not been incorporated into the total allocated amount of water in the subbasins. Applications have been submitted to WDOE but have not been processed and as such the allocation requests do not necessarily reflect the appropriate amount that might be awarded after processing. In addition, volume limits are set by WDOE and are therefore not yet available.

- Supplemental rights were not explicitly analyzed in this study, with one exception. The City of Lacey's supplemental rights in the McAllister Subbasin have been separated from their primary rights and only the annual volume limits associated with the latter have been included in the analysis.

- The awarded water rights that are found in the WRATS database were assumed to be currently used. It is likely that numerous water rights on the books have not been used for years, yet at this level of analysis there is no easy way to determine which rights those are. A more detailed analysis of water rights' places of use would need to be mapped and compared to parcel maps from the assessors' databases to understand the extent of those unused rights.

WATER RIGHTS SUMMARIES AND FINDINGS

In the Lower Nisqually River Basin (Figure 5.3-1), there were a total of 938 certificates, permits, and applications (Table 5.3-1, Figure 5.3-2) and 2,677 claims (Table 5.3-2). The database contained 631 rights or claims that were located outside of WRIA 11; these were not included in this analysis. The total allocated amount for diversions/withdrawals was 1096.56 cfs with an annual volume limit of 63,078 acre-feet without hydropower (additional 58,000 acre-feet). The total volume of storage rights was about 265 acre-feet. The water rights cover roughly 9,689 acres of irrigated land; 842 of these acres were listed under applications.

There were three power rights in the basin, all surface water diversions that allow 802.50 cfs to be diverted. Only one of the three diversions had an associated annual volume limitation; one could assume that under the other two rights, the diversion amount (722.5 cfs) could be continuously removed from the river throughout the year. These rights are non-consumptive and only have an effect on the bypass reaches, between the point of diversion and the return flow. The City of Centralia holds two of these surface water rights for 800 cfs in total; 80 cfs of this has the 58,000 acre-feet limitation. There is an additional power right for 2.50 cfs under the name LC Fitch dated 1932.

The majority of the consumptive water right allocations in the Lower Nisqually were designated for municipal, multiple domestic, and irrigation water use.

Most of the claims for water use in the Lower Nisqually were intended for general domestic purposes. It is likely that many of these users are served by either a public water system or an exempt well. The irrigation claims totaled 1,392 acres under 64 claims; some of these could show up as being covered by an existing water right in a future water rights mapping effort.

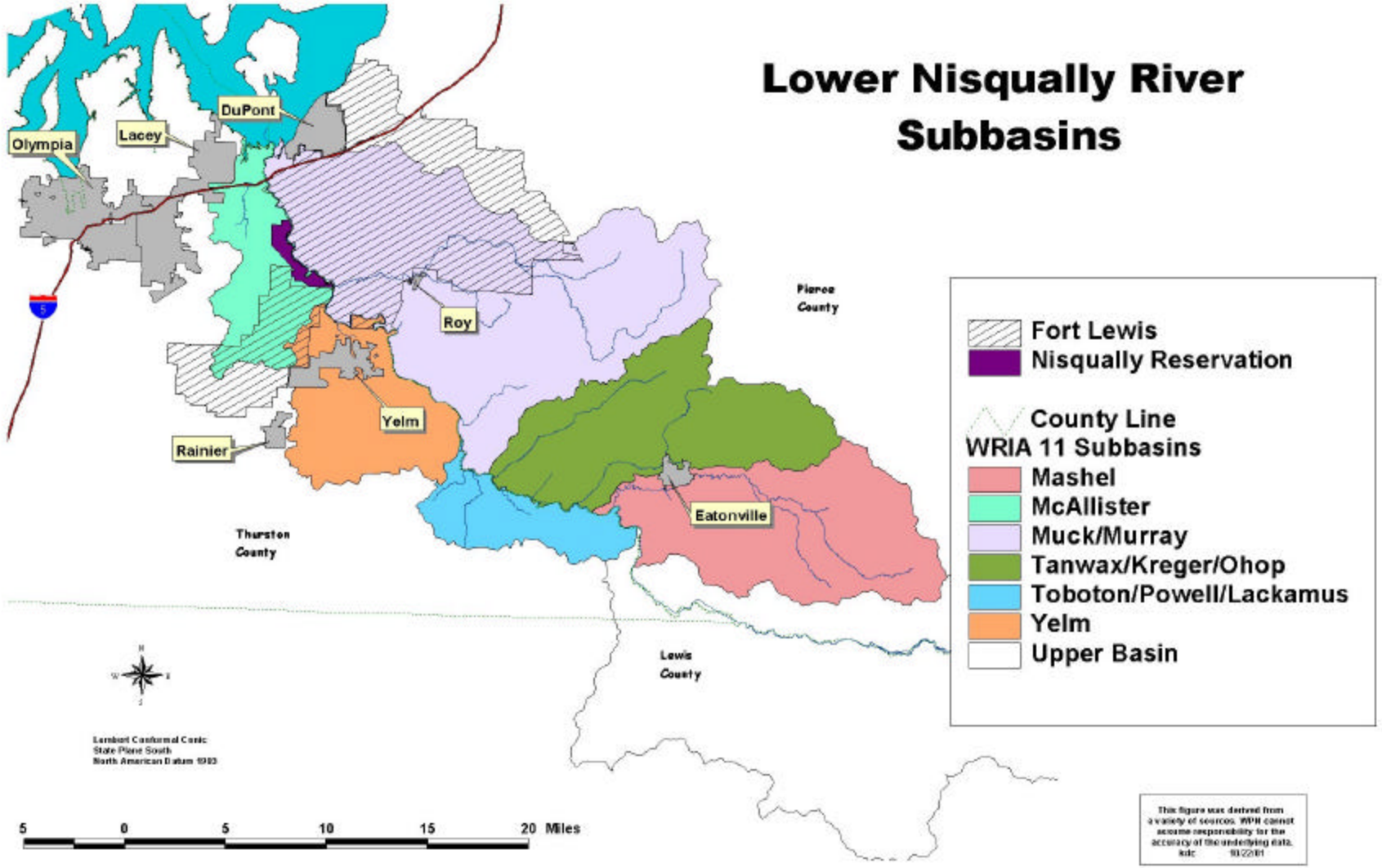


Figure 5.3-1: Lower Nisqually Basin (WRIA 11) – Location Map and Subbasin Identification

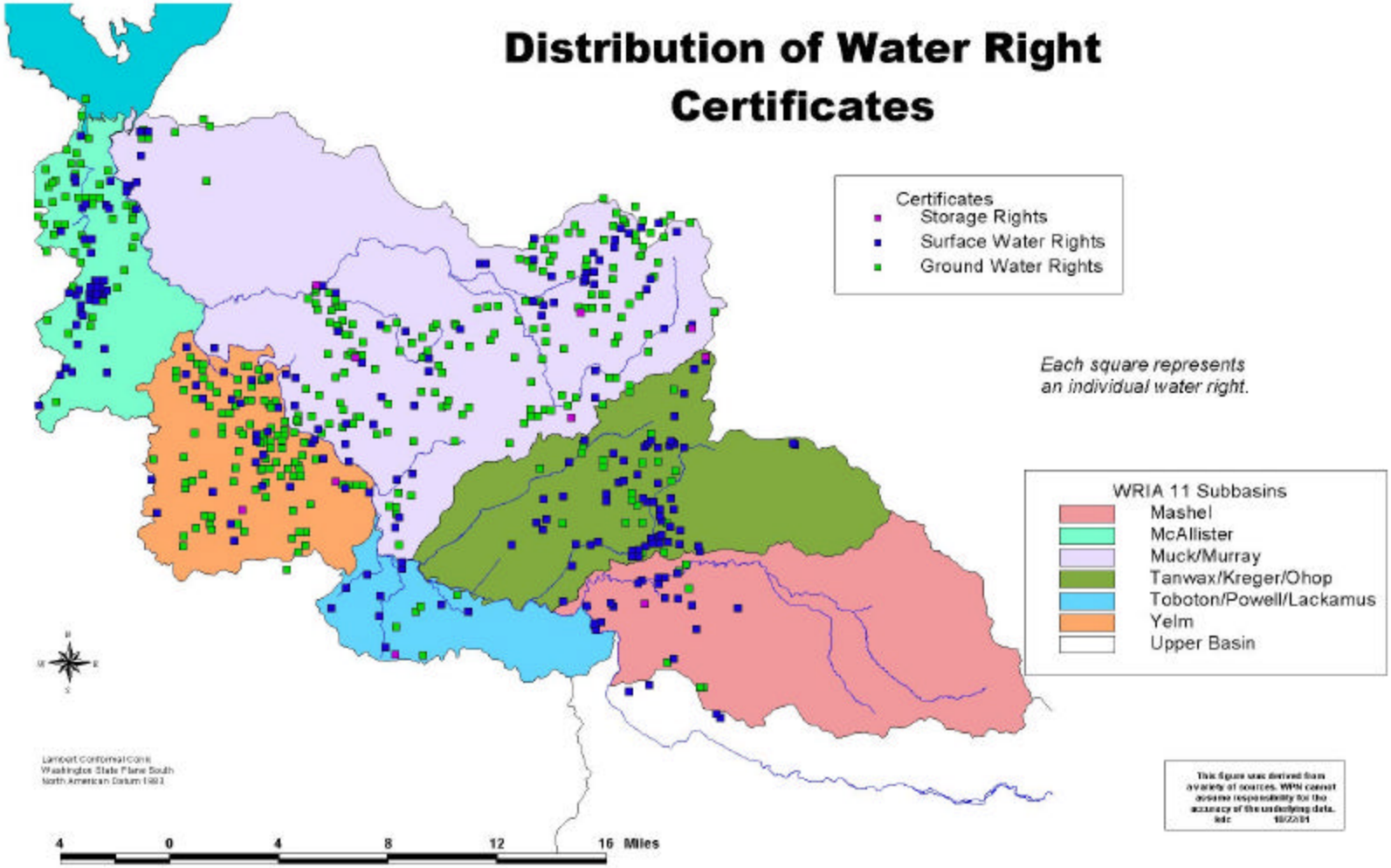


Figure 5.3-2: Lower Nisqually Basin (WRIA 11) – Distribution of Water Right Certificates [Does not include certificates held by the City of Lacey that were found in the WRIA 13 database; they are however included in Table 5.3-1]

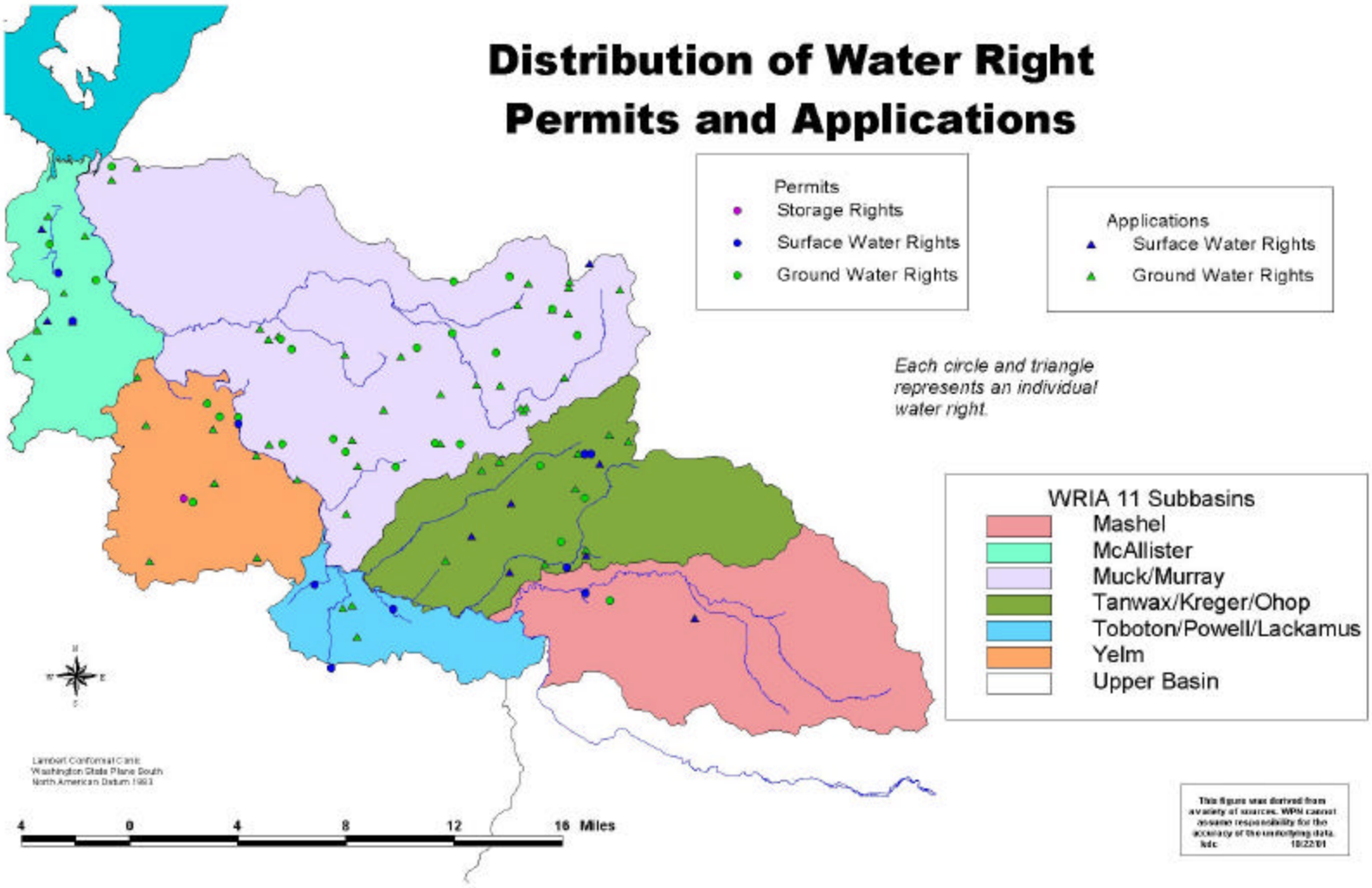


Figure 5.3-3: Lower Nisqually Basin (WRIA 11) – Distribution of Water Right Permits and Applications [Does not include pending applications by the City of Lacey that were found in the WRIA 13 database; these are included in Table 5.3-1]

Table 5.3-1: Lower Nisqually River Basin (WRIA 11) - Summary of Water Rights By Primary Beneficial Use

	All Certificates					Ground Water Certificates				Surface Water Certificates				Storage	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
Primary Beneficial Use	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Commercial/Industrial	7	0.77	363	628	0	5	363	66	0	2	0.77	562	0		
General Domestic	1	0.00	60	20	0	1	60	20	0	0	0.00	0	0		
Multiple Domestic	220	3.17	14,547	6,415	0	198	14,547	5,750	0	22	3.17	665	0		
Single Domestic	158	1.78	599	324	2	36	599	234	0	122	1.78	91	2		
Environ. Quality	1	0.00	35	13	0	1	35	13	0	0	0.00	0	0		
Fire Protection	14	3.67	300	238	0	6	300	209	0	7	3.67	23	0	1	6
Fish Propagation	19	56.06	950	940	0	2	950	921	0	16	56.06	12	0	1	8
Irrigation	265	33.93	22,486	13,184	6,817	137	22,486	7,209	3,752	127	33.93	5,922	3,066	1	54
Municipal	25	30.33	7,758	26,125	0	23	7,758	4,173	0	2	30.33	21,952	0		
Power	3	802.50	0	58,000	0	0	0	0	0	3	802.50	58,000	0		
Recreation	11	3.49	350	260	0	3	350	58	0	5	3.49	70	0	3	132
Rail Way	4	0.14	150	122	0	2	150	122	0	2	0.14	0	0		
Stock	84	4.26	10,836	4,806	1,833	58	10,836	4,290	1,588	26	4.26	516	245		
Wildlife	12	2.31	540	646	135	3	540	558	120	4	2.31	22	10	5	66
Totals:	**824**	**942.41**	**58,975**	**111,720**	**8,787**	**475**	**58,975**	**23,621**	**5,460**	**338**	**942.41**	**87,835**	**3,322**	**11**	**265**

	All Permits					Ground Water Permits				Surface Water Permits				Storage	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
Primary Beneficial Use	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Multiple Domestic	23		2,312	881	0	23	2,312	881	0						
Single Domestic	6	0.11	0	3	0					6	0.11	3	0		
Fish Propagation	2	0.05	20	4	0	1	20	4	0	1	0.05	0	0		
Irrigation	3	0.54	50	40	20	1	50	10	5	2	0.54	30	15		
Municipal	4	10.00	2,940	8,290	0	3	2,940	1,063	0	1	10.00	7,227	0		
Recreation	2		110	140	40	1	110	140	40					1	
Totals:	**40**	**10.70**	**5,432**	**9,358**	**60**	**29**	**5,432**	**2,098**	**45**	**10**	**10.70**	**7,260**	**15**	**1**	**0**

	All Applications					Ground Water Applications				Surface Water Applications				Storage	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
Primary Beneficial Uses	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Multiple Domestic	31	0.18	5,174	0	0	30	5,174	0	0	1	0.18				
Single Domestic	6	0.07	29	0	0	2	29	0	0	4	0.07				
Frost Protection	1		225	0	0	1	225	0	0						
Irrigation	19	3.72	3,080	0	790	15	3,080	0	747	4	3.72		43		
Municipal	10	0.00	30,040	0	0	10	30,040	0	0						
Power	2	0.44		0	0					2	0.44				
Stock	5		980	0	53	5	980	0	53						
Totals:	**74**	**4.41**	**39,528**	**0**	**842**	**63**	**39,528**	**0**	**799**	**11**	**4.41**	**0**	**43**	**0**	**0**

TOTAL:	**938**	**957.52**	**103,935**	**121,078**	**9,689**	**567**	**103,935**	**25,718**	**6,304**	**359**	**957.52**	**95,095**	**3,380**	**12**	**265**

Table 5.3-2: Lower Nisqually Basin (WRIA 11) – Summary of Water Claims by Number and Beneficial Use

Subbasin	Surface Water	Ground Water	Combined Surface and Ground Water Claims	Total # Claims	Primary Beneficial Use					
					General Domestic	Irrigation	# Acres	Stock	Unknown	Total
McAllister	48	233	0	**281**	259	7	**96**	6	9	281
Muck/Murray	93	1,159	3	**1,255**	1,156	21	**368**	51	27	1,255
Yelm	24	540	0	**564**	531	11	**321**	19	3	564
Toboton/Powell/Lackamas	8	45	0	**53**	50	1	**100**	2	0	53
Tanwax/Kreger/Ohop	150	301	2	**453**	409	14	**390**	20	10	453
Mashel	28	43	0	**71**	47	10	**117**	11	3	71
Total	**351**	**2,321**	**5**	**2,677**	**2,452**	**64**	**1,392**	**109**	**52**	**2,677**

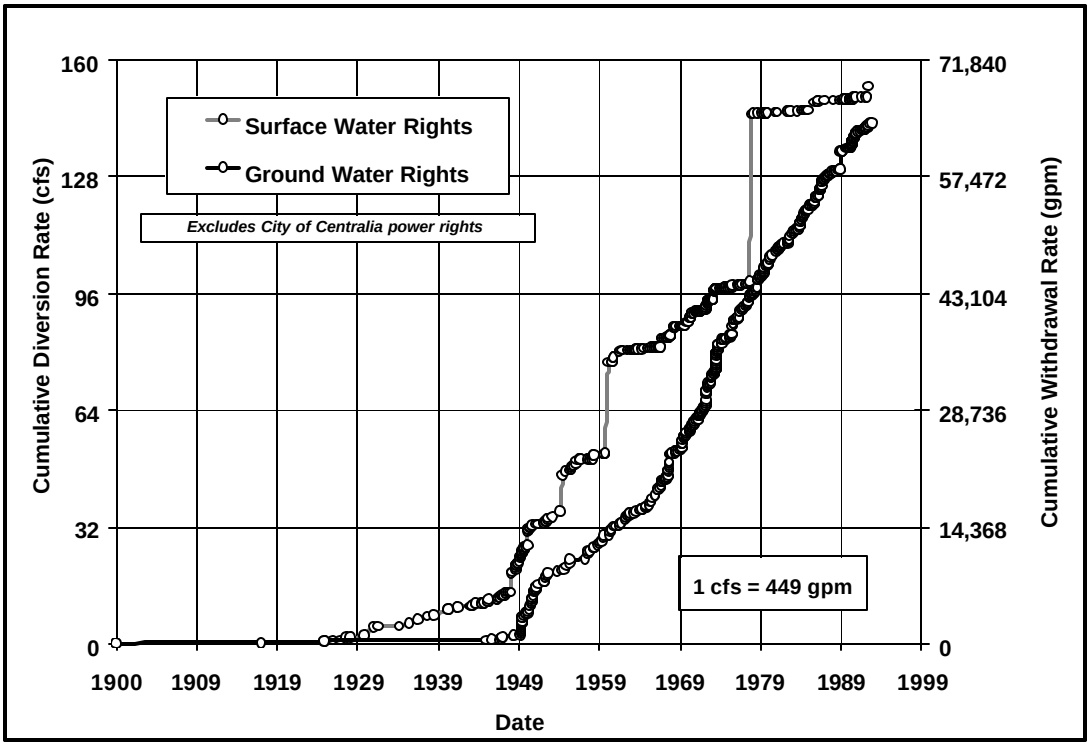


Figure 5.3-4: Lower Nisqually Basin of WRIA 11 – Water Allocated Over Time

The allocation of consumptive water has been roughly even between surface and ground water sources. The total surface water diversion rate was 150.61 cfs while the total ground water withdrawal rate was 64,407 gpm or 143.45 cfs. With the exception of three large rights (>10 cfs) for municipal, commercial, and fish production, the rights were relatively small (<10 cfs). These rights can be noted as sharp increases on the surface water rights curve (Figure 5.3-3). The ground water rights increase at a relatively constant rate over time.

Of the three largest surface water rights, the City of Olympia holds two; one certificate for 25 cfs and one permit for 10 cfs for municipal and commercial/industrial use dated 1941, and 1955, respectively. By volume, the allocation for municipal rights is the largest (Figure 5.3-6). The Washington Department of Fish and Wildlife holds the other large right (46 cfs) for fish production, priority date 1978.

Of the ground water rights, the City of Dupont holds the largest, a permit (multiple domestic) for 2,200 gpm (4.90 cfs) with a priority date of 1989. The next largest ground water right was for irrigation of 125 acres and a supply for one home; the certificate was awarded for 1,020 gpm (2.27 cfs) and given a priority date of 1968. There were three

rights for a total of 1,000 gpm (2.23 cfs); one certificate for the irrigation of 150 acres as well as a supply for stock and multiple domestic and two applications, one for Clearwood Community and one for the City of Yelm, each for 1000 gpm.

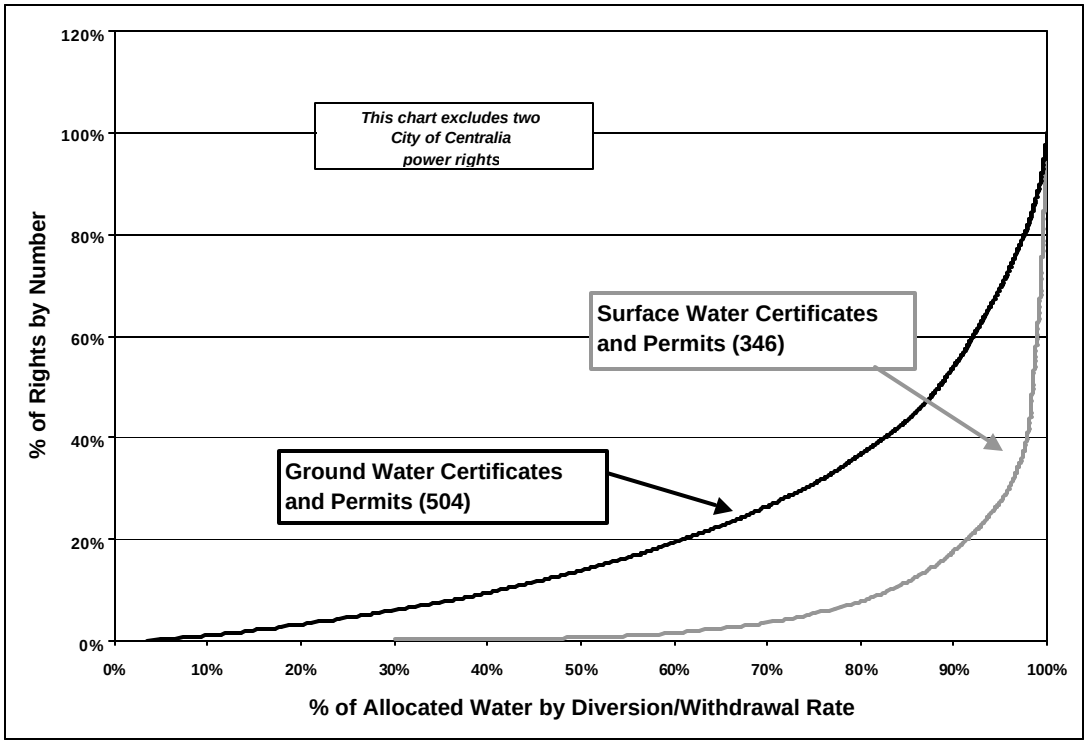


Figure 5.3-5: Lower Nisqually Basin of WRIA 11 – Percent of Rights Covering Percent Allocated Water

About 11% (40 in number) of the surface water rights cover 85% of the allocated water based on the diversion rate. By contrast, 44% (220) of the ground water rights cover 85% of the allocated water based on the withdrawal rate. Ninety-five percent of the ground water allocation was covered by 70% (351) of the rights while 27% (95) covered the same percentage of surface water allocation. When conducting future analyses, this information will be important. For example, if you want to understand exactly where the actual places of use and points of diversion are located, it might be wise to plot the top 95 surface water rights rather than all 346 rights (348 with power rights) since those few cover 95% of the allocation, while significantly more ground water rights would have to be plotted for the same result. As a cost savings measure, the Planning Unit might decide that analyzing the rights covering 85% of the total allocation will allow them to get a sufficient understanding of water use to develop a watershed plan for the basin.

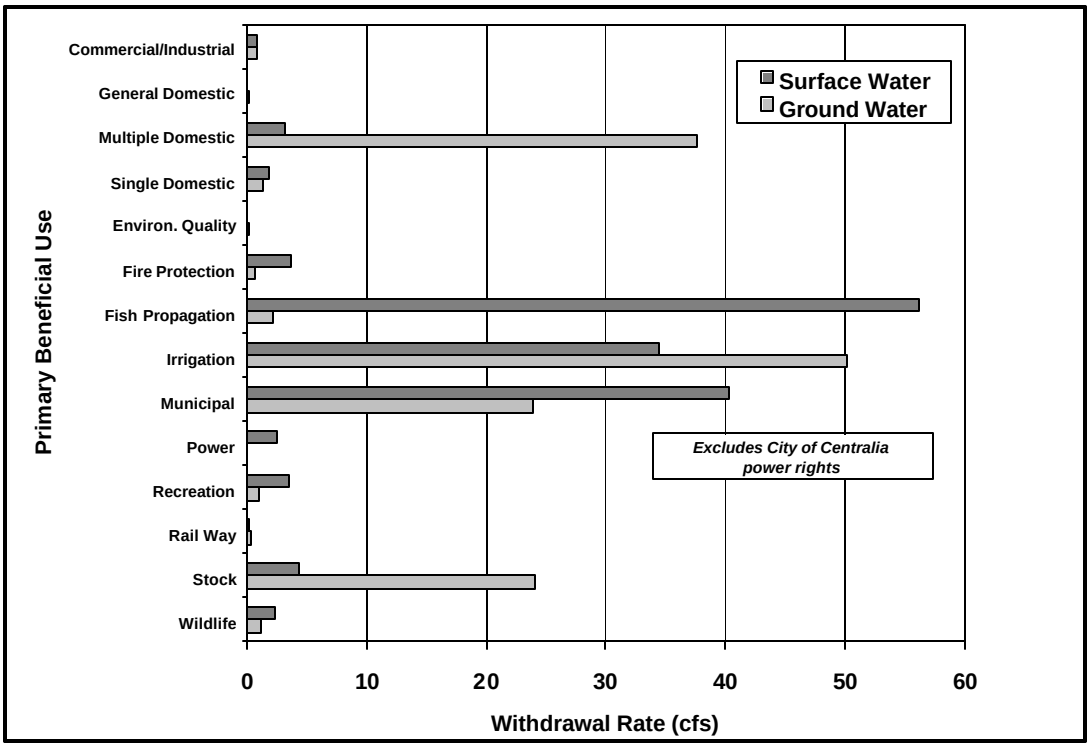


Figure 5.3-6: Lower Nisqually Basin– Summary of Diversion/Withdrawal Allocation by Primary Beneficial Use (cfs)

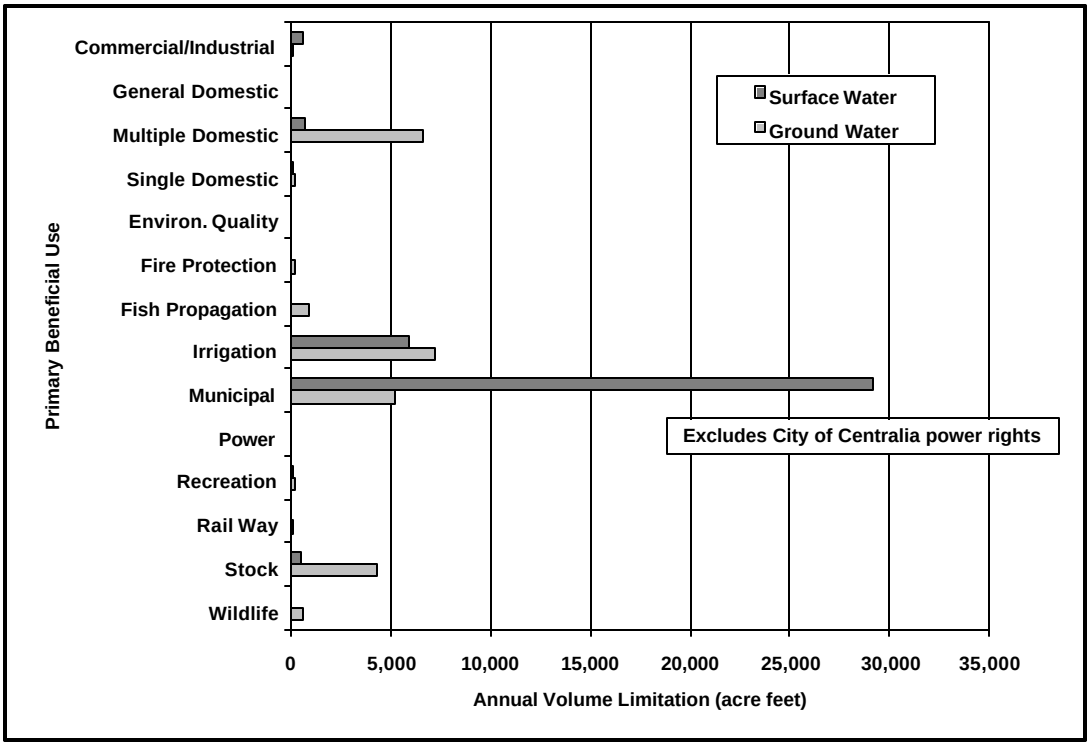


Figure 5.3-7: Lower Nisqually Basin – Summary of Volume Allocations by Primary Beneficial Use (acre-feet)

WATER USE

Estimates of actual water use have not previously been determined on a watershed – wide basis for the entire Lower Nisqually Basin WRIA 11 or for the individual subbasins. Except for large diversion/withdrawals for municipal or multiple domestic uses, water use has not been systematically recorded. In the absence of such data, the estimate of actual water use is not as accurate as it would be with these data. In this document, an estimate of current and future residential water use and an estimate of the current irrigated acreage were developed. In a more detailed assessment, a survey of the agricultural lands would provide information of current irrigated lands, however, there appears to be no documentation of such at the present time. Irrigation and municipal/multiple domestic use were the largest consumptive water use categories in this WRIA based on the water rights database, hence the reason for assessing the actual use for these sectors. Water rights specifically for commercial use were small, totaling 138 acre-feet for the whole Lower Nisqually Basin (Table 5.3-1). Further investigation into commercial use within public water systems can provide actual use estimates of this category of service.

Public water systems report the number of residential and non-residential connections. The latter are generally commercial uses however no attempt was made within this document to identify the commercial water use associated with each public water system. Commercial water use is taken into account when comparing allocated water and streamflow. For example, municipal water rights cover some level of commercial use. As noted above, commercial rights were few and the total volume associated with such rights was small.

RESIDENTIAL WATER USE

Actual residential water use was estimated using population statistics and per capita water usage. This information was provided to understand the difference between actual use and water righted use. However, when comparing the water right allocations to streamflow, the water right annual volume allocations (Table 5.3-2) were used. The full annual volumes were distributed between winter and summer seasons for single domestic, multiple domestic, and municipal uses as well as other types of uses.

Data Sources

The water use estimates developed for this analysis were based on population data from the 2000 census (GeoLytics, 2001). The new population numbers were compared to the 1990 census data as a means of comparing the change in population over the past ten years. Published documents with actual water use estimates were used and summarized in the section *Actual water use from published documents.* In addition, the Water System Design Manual (WDOH, 1999) equations were used to estimate average day demand and maximum day demands for each of the subbasins as described in the section entitled *Method of estimating per capita water usage*.

Population

The estimate of current and future water use is, in part, based on population statistics. Population data are most often summarized by political boundaries rather than watershed boundaries, making it difficult to translate the data into water use for a particular basin or subbasin. The Lower Nisqually Basin encompasses a portion of Thurston and Pierce Counties. Population statistics, such as number of people per household, census data, and population projections into the 21st century for these two counties, were the primary sources (Census Bureau: (http://venus.census.gov/)) used to develop water use estimates (Table 5.3-3).

Table 5.3-3: Population data for 1990 and 2000

Subbasin	County	Population 1990	Population 2000	% increase/year over 10-year period	Population served by PWS (2000)	% Populations served by PWS (2000)
McAllister	Thurston	11,150	13,590	2.19%	12,030	91
Muck	Pierce	17,435	27,454	5.75%	20,355	71
Yelm	Thurston	7,396	11,288	5.26%	7,186	64
Toboton/Powell /Lackamus	Thurston	716	1,591	12.22%	1,327	83
Tanwax/Kreger/ Ohop	Pierce	3,310	4,571	3.81%	972	21
Mashel	Pierce	1,695	2,279	3.45%	2,162	95
Lower WRIA		**43,692**	**60,773**	**4.37%**	**44,032**	**72**

*(Calculated from shapefiles in ArcView)

Future population projections for Thurston County were obtained from the Economic Development Council website (http://www.thurstonedc.com/demos/Demo.html). Population projections for Pierce County were obtained from the Tacoma-Pierce County Economic Development Board (Suess, 2001). The anticipated growth rates for Thurston and Pierce Counties over the next 20 years is 50% and 33%, respectively. This translates to an annual growth rate of 2.5% per year for Thurston County and 1.7% per year for Pierce County. While Pierce County numbers may reflect the growth in Tanwax/Kreger/Ohop and Mashel, they appear low for Muck Creek Basin. Muck Creek Basin is inside the urban growth boundary of Pierce County and would likely experience higher growth rates. Therefore, an annual growth rate of 5.75% was used to determine future population figures in Muck Creek Subbasin.

The year 2020 was selected for the future demand scenario since these projections were most readily available (Table 5.3-4). Estimates further out can be determined in a Level 2 analysis, if necessary.

Table 5.3-4: Population projections for each subbasin

Subbasin	Year 2000 Population	Year 2020 Population
McAllister[1]	13,590	20,385
Muck[2]	27,454	47,490
Yelm[1]	11,288	16,932
Toboton/Powell/Lackamus[1]	1,591	2,387
Tanwax/Kreger/Ohop[3]	4,571	6,079
Mashel[3]	2,279	3,031
Total	**60,773**	**96,304**

[1]Projected population based on Thurston County statistics.
[2]Based on Census 1990 and 2000 for Muck Creek Basin.
[3]Projected population based on Pierce County statistics.

Actual water use from published documents

Reference documents provided for this study reported water use for certain entities. The per capita water usage ranged from 113 gallons per day (gpd) to 186 gpd with the average between 141 and 156 gpd. (Gallons per capita per day = gcd)

- Town of Eatonville 155 to 186 gcd
- City of Lacey 148 gcd
- Graham Hill Mutual Water Company 113 gcd
- McKenna Water District 125 to 154 gcd
- Pierce County Coordinated Water System Plan 170 gcd
- City of Yelm 123 to 155 gcd
- City of Olympia 156 to 166 gcd

Because of the wide range of water use information and the nature of this study as a Level 1, the WDOH design demand equation was used to estimate water use on a

subbasin basis. This procedure is described below and results in an average per capita usage of 145 gcd over the entire Lower Nisqually of WRIA 11.

Method of estimating per capita water usage

In the absence of actual water use records or insufficient and/or inconsistent data, an estimate of residential water use can be determined by using design standards for the development of public water systems (WDOH, 1999). The Water System Design Manual (WDOH, 1999) bases its determination of water demand on average annual rainfall by the following equation:

$$\mathbf{ADD = (8{,}000/AAR) + 200}$$

Where, **ADD** = average day demand per equivalent residential unit (ERU);

AAR = average annual rainfall.

An ERU was defined as a residential unit equivalent to a single-family residence. The average number of people per household must also be determined to convert the ADD to an average daily demand per person (gallons per capita per day = gcd).

The monthly distribution of water for residential water use is constant for in-house use, but increases primarily in the months of July, August, and September when precipitation is the lowest and crop water requirements for lawns and gardens are highest. Outside lawn and garden watering can increase summertime demand by more than 50% (WDOH, 1998). In the Water System Design Manual (1999), the recommended maximum day demand for designing water systems is:

$$\mathbf{MDD = 2 \; X \; ADD}$$

Where, MDD = maximum day demand.

The average annual precipitation for each subbasin was used to determine residential water use (Table 5.3-5). The average day demand for one single-family residence ranged from 313 gpd in the Mashel subbasin to 411 gpd in the Toboton/Powell/Lackamus subbasin. The maximum day demand ranges from 626 to 822 gpd per equivalent residential unit.

From the 1990 census data, there were approximately 2.55 people/household in Thurston County and 2.62 people per household in Pierce County. Using these statistics (the 2000 population numbers were available but not the summary statistics), the average daily per capita water demand was computed and ranged from 119 gcd (gallons per capita per day) to 157 gcd. The maximum day demand (double the average day demand) ranged from 238 gcd to 314 gcd. The latter values represent water use during periods of extensive outside lawn and garden watering in the dry season.

Table 5.3-5: Residential Water Use Estimates Based on Population

Subbasin	Year 2000 Population	Average Annual Precipitation[1] (inches)	Average Day Demand [ADD] (gpd/ERU)[2]	Per Capita Ave Day Demand [ADD]		Per Capita Max Day Demand [MDD]	
				gcd	cfs	gcd	cfs
McAllister	13,590	45	378	148	3.11	296	6.22
Muck/Murray	27,454	42	390	153	6.50	306	13.00
Yelm	11,288	43	386	151	2.64	302	5.27
Toboton/Powell /Lackamus	1,591	38	411	157	0.39	314	0.77
Tanwax/Kreger /Ohop	4,571	46	374	143	1.01	286	2.02
Mashel	2,279	71	313	119	0.42	238	0.84
Total	**60,773**				**14.07**		**28.12**

[1] from Hydrology Chapter

[2] ERU = equivalent residential unit ~ 1 single-family residence

Return Flow from Residential Water Use

A significant portion of lawn and garden irrigation water is lost to evapotranspiration while the remaining water either becomes subsurface flow or overland flow; the amount returned can be as much as 50% of the withdrawal. For houses on septic systems, in-house domestic water use consumes an estimated 13% of the water delivered, the remainder (87%) returns to ground water (Solly et.al. 1993). Houses on sewer service can also return much of the water to either surface or ground water depending on the configuration of the treatment system. Wastewater treatment at a centrally located plant will discharge water back to the river at a designated point while systems using lagoons may provide some local ground water recharge. Septic systems will delay the return flow as the wastewater is filtered through the leach field following subsurface pathways, a

portion of which may return to a surface water body and a portion of which may return to ground water. Most homeowners use sprinkler systems to irrigate lawns and gardens.

Keeping these concepts in mind, residential water withdrawals have associated return flows that must be accounted for in a water balance. The reach of the river that experiences the total impact of the withdrawal is between the point of diversion and the point of return. Therefore, downstream of the point of wastewater discharge, the impact is less than the total diversion.

Assumptions

Residential Water use

- On a basin-wide basis, residential water use was 145 gcd in the winter months and 290 gcd during the summer months. The specific calculations for each subbasin were used in those sections. These values were based on WDOH design demand equations and are similar to those reported for the individual entities in *Actual water use from published documents.*

Residential Return Flow

- Return flow in the winter months (October through April) assuming no outside use was 87% of winter residential water use or **126 gcd** (basin-wide average). In other words, the depletion in streamflow due to residential water use is 13% (Solly et.al. 1993).

- Return flow in the summer months (May through September) was 87% for in-house use and 57% for irrigation of lawn and gardens (Solly et.al. 1993). A weighted return flow was calculated as follows: (basin-wide average)

Return Flow = (145*.87) + (145*.57) = 209 gcd

Depletions = total use- return flow

Depletions = 290 gcd – 209 gcd = 81 gcd (28%)

- This method was used to determine the return flow from residential water use in each of the six subbasins.

- This method was also used for estimating depletions associated with water rights volume limitations in the sections entitled "Comparison of Streamflow and Allocated Water" for each subbasin.

Residential Water Use

Using the above stated assumptions, an estimate of residential water use and return flow for the year 2000 population was calculated for each subbasin and for the entire Lower Nisqually Basin (Table 5.3-6). Overall, the average demand of about 14 cfs results in a net depletion to the ground/surface water system of slightly more than 2 cfs. The summer season demand increases to more than 28 cfs with a net depletion of more than 8 cfs.

The residential water demand was developed for the in-basin population only and does not reflect out-of-basin transfers such as the water rights held by the City of Olympia or the City of Lacey. The out-of-basin exports were however included in the net depletion calculations of the full water rights entitlements in the section entitled *Comparison of Streamflow and Allocated Water*. To understand fully the impact of the water systems' exports from WRIA 11, more detailed analyses would be necessary under a Level 2 study.

Table 5.3-6: Estimated Residential Water Use and Net Effect – Year 2000

Subbasin Name	Year 2000 Population	October through April			May through September		
		Average Day Demand (cfs)	Return Flow (cfs)	Net Depletion of Water Use (cfs)	Max Day Demand (cfs)	Return Flow (cfs)	Net Depletion of Water Use (cfs)
McAllister	13,590	3.11	2.29*	**0.82***	6.22	4.58*	**1.64***
Muck/Murray	27,454	6.50	5.66	**0.84**	13.00	9.36	**3.64**
Yelm	11,288	2.64	2.3	**0.34**	5.27	3.79	**1.48**
Toboton/Powell/ Lackamus	1,591	0.39	0.34	**0.05**	0.77	0.55	**0.22**
Tanwax/Kreger/ Ohop	4,571	1.01	0.88	**0.13**	2.02	1.45	**0.57**
Mashel	2,279	0.42	0.37	**0.05**	0.84	0.60	**0.24**
TOTAL	**60,773**	14.07	11.96	**2.11**	28.12	19.93	**8.19**

* These figures account for the sewer connections (100% depletion from in house use) in McAllister that are served by the City of Lacey.

The effect of Yelm's water reuse and recharge program are also not incorporated into the estimates of use. The approach used accounts for consumptive use. That which was not consumptive was assumed to return as return flow. The Yelm project does not affect the estimates of overall consumptive use. It does, however, affect groundwater recharge (see Chapter 5.2).

Comparable data were developed for each of the subbasins and are reported in Tables 5.3-6 and 5.3-7. Further discussion of the subbasin estimates occurs in *Subbasin Summaries and Findings*.

Estimates of Future Residential Water Use

Estimates of future residential water use were calculated using the projected population figures previously developed and the same average and maximum day demands estimated in Table 5.3-5. The average demand estimates for the year 2020 population projections may be more than 20 cfs with a 13% (3.3 cfs) net depletion to the ground/surface water system. During the season of outdoor water use, usually from May through September, the demand could reach as much as 45 cfs with a net depletion of 28% (13 cfs), given the stated assumptions for return flow and per capita water use.

Table 5.3-7: Projected Residential Water Demand and Net Impact – Year 2020

Subbasin Name	Projected Year 2020 Population	October through April			May through September		
		Average Day Demand (cfs)	Return Flow (cfs)	Net Depletion of Water Use (cfs)	Max Day Demand (cfs)	Return Flow (cfs)	Net Depletion of Water Use (cfs)
McAllister	20,385	4.67	3.62*	1.05*	9.34	6.28*	3.06*
Muck/Murray	47,490	11.24	9.78	1.46	22.48	16.19	6.29
Yelm	16,932	3.96	3.45	0.51	7.92	5.70	2.22
Toboton/Powell/Lackamus	2,387	0.58	0.5	0.08	1.16	0.84	0.32
Tanwax/Kreger/Ohop	6,079	1.34	1.17	0.17	2.68	1.93	0.75
Mashel	3,031	0.56	0.49	0.07	1.12	0.81	0.31
TOTAL	**96,304**	22.35	19.01	3.34	44.7	31.75	12.95

* These figures account for the sewer connections (100% depletion from in house use) in McAllister that are served by the City of Lacey.

PUBLIC WATER SYSTEMS

Data Sources

Public Water Systems supply a large percent of the estimated residential water use. The Washington Department of Health (WDOH) maintains a database of all the public water systems in the state including information such as the source location (to the nearest quarter-quarter section), the population served by each system, and the number of residential and non-residential connections. Initially, the database for the Lower Nisqually was obtained from WDOH. In addition, both Pierce and Thurston Counties had developed arcview shapefiles that displayed public water system boundaries for some of the Group A systems. The Lower Nisqually WDOH dataset appeared to be missing some of the public water systems that were found in the county generated data. Because of inaccuracies in the WDOH database for the Lower Nisqually, the WDOH data for the entire state was obtained so that all of the public water systems could be extracted from the set.

Methods for Summarizing Public Water System Data

To summarize public water systems (PWS) in the Lower Nisqually Basin (WRIA 11), information was gathered from various sources: County shapefiles (spatial display of data) from the Thurston County Geodata Center and Pierce County GIS office; and the Department of Health (WDOH) PWS database. The database was first obtained from WDOH for WRIA 11 only. Two files were provided: one listed 490 public water systems and one listed the water source locations for only 103 of these (the locations for 387 PWSs were missing). Using the file with the source locations and cross-referencing this file with the county shapefiles uncovered many water systems that were missing from either the county shapefiles or the WRIA 11 WDOH database. For example, the City of Eatonville PWS was not in the WDOH database but was in the Pierce County shapefile. Eatonville is centrally located in WRIA 11 in the Mashel subbasin and has a population just over 1,000 people. Contacting WDOH revealed that Eatonville was listed as WRIA 17, not as WRIA 11. Other water systems were missing due to similar mistakes in WRIA location. Smaller public water systems such as Group B systems, included in the WDOH listing, were not included in the county shapefiles. Using the WDOH database for WRIA 11 and the two county shapefiles, only 117 PWS were initially identified in the lower Nisqually subbasins.

Since many public water systems were either missing their source locations inaccurately listed, or missing from the database altogether, a new approach was taken to determine which PWSs were in Lower WRIA 11. Source locations for Group A and B Public Water Systems for all of Washington State were obtained from WDOH and overlaid on the WRIA 11 boundary. All the source locations within the Lower Nisqually Basin of WRIA 11 became the new database file. Population and connection information were then added to the database from a separate file provided by WDOH. The new database file provided the information to summarize the water use within the subbasin and for the entire Lower Nisqually Basin.

In comparing the new base file to the county shapefile, several public water systems were still missing from WDOH database. Some systems, although present in the database, did not have source location information, however, these data were available in other files provided by WDOH. Linking the sources of data, the missing PWS locations were then added to the spatial display of data for a fairly complete representation of all the PWS that have their source within the Lower Nisqually Basin. This method of basing PWS on their source location, rather than their WRIA location, resulted in a total of 559 public water systems in the study area.

Linking the databases showed that some water systems had several sites listed as source locations, usually as a group of wells. Sources for water systems were primarily wells although some sources were springs or rivers. Several Group A systems had well source locations both in and out of the six subbasins. These included the City of Dupont, Fort Lewis Water System, the City of Lacey, Pattison Water Company, Sound Water, and Southwood Water System. These systems were unique too in that the water system's physical location was only partially in WRIA 11. Therefore these systems are at least partially exporters of water from WRIA 11 for use in another watershed area.

Determination of population for these systems was based on the 2000 Census by census blocks. The service area that lay within the subbasin boundaries were compared to the corresponding census block population to arrive at an estimate of population served within the WRIA 11 subbasin. Number of connections for the population in the subbasin was based on population percentage of total population. The City of Lacey provided the number of connections in WRIA 11 so that estimating by population statistics was unnecessary for this system.

Assumptions

- Since service area boundaries were not available for all of the public water systems, the point of withdrawal was used as the identifier for assigning the water system to the appropriate subbasin. This assumed that both the point of withdrawal and service area for a given public water system fell within the boundaries of one subbasin. The locations of the systems can be refined, if necessary, in a Level 2 assessment, by using actual service area boundaries rather than the source water location.

- Where information on public water systems is available, it can be used in conjunction with the population data. Population served by public water systems can be subtracted from the total basin population to ascertain an approximate number of people not served by public water systems. These people are served by either exempt wells or individual water rights.

Public Water System Summaries

Information for all the water systems in WRIA 11 is summarized by subbasin (Tables 5.3-10 and 5.3-11). There were 559 public water systems on the WDOH list (2001), 122 Group A and 437 Group B systems. Group A systems represent the larger facilities that serve 15 or more connections or 25 or more people/day for 60 or more days/year. Group

B systems serve 1) less than 15 connections and less than 25 people for 60 or more days/year or 2) any number of people for less than 60 days per year or 3) less than 15 connections in use less than 60 days per year.

Table 5.3-8: Public Water Systems by Subbasin

Subbasin Name	Group A Systems	Group B Systems	Total
McAllister	28	35	63
Muck	53	291	344
Yelm	23	53	76
Toboton/Powell/Lackamus	5	2	7
Tanwax/Kreger/Ohop	11	50	61
Mashel	2	6	8
Total	**122**	**437**	**559**

A summary of the WDOH data indicated the total resident population served by a public water system was 44,032 in the Lower Nisqually Basin; total resident connections were 17,246. Using these data, the number of people per household was 2.55. The Pierce County average was 2.62 people per dwelling unit, as found in the U.S. Census Bureau database, while the Thurston County average was slightly lower at 2.55 people per dwelling unit estimated by the U.S. Census Bureau.

Table 5.3-9: Public Water System Population and Connections by Subbasin[1]

Subbasin Name	Population	Residential Connections	Non-Residential Connections	Total Connections
McAllister	12,030	4,827	455	5,282
Muck/Murray	20,355	7,887	180	8,067
Yelm	7,186	2,799	120	2,919
Toboton/Powell/Lackamus	1,327	557	972[2]	1,529
Tanwax/Kreger/Ohop	972	357	151	508
Mashel	2,162	819	123	942
Total	**44,032**	**17,246**	**10,751**	**19,247**

[1]These data were obtained from the WDOH in 2001.
[2] Clearwood Water System reported 871 non-residential connections most of which are not in use (some are used for camping hookups)

The population served by public water systems represents about 72% of the total Lower Nisqually Basin population. The source for public water systems are generally

large production wells with significant depths while those self-supplied usually have shallower, lower yield wells. Self-supplied water users either have water rights to cover their withdrawals or are under the exempt well status.

Table 5.3-10: Portion of Population Served by Public Water Systems

Subbasin Name	Year 2000 Population	Year 2000 Population Served by PWS	Percent of Population Served by PWS	Percent of Population Self-Supplied
McAllister	13,590	12,030	86%	14%
Muck/Murray	27,454	20,355	74%	26%
Yelm	11,288	7,186	64%	36%
Toboton/Powell/Lackamus	1,591	1,327	83%	17%
Tanwax/Kreger/Ohop	4,571	972	21%	79%
Mashel	2,279	2,162	95%	5%
TOTAL	**60,773**	**44,032**	**72%**	**28%**

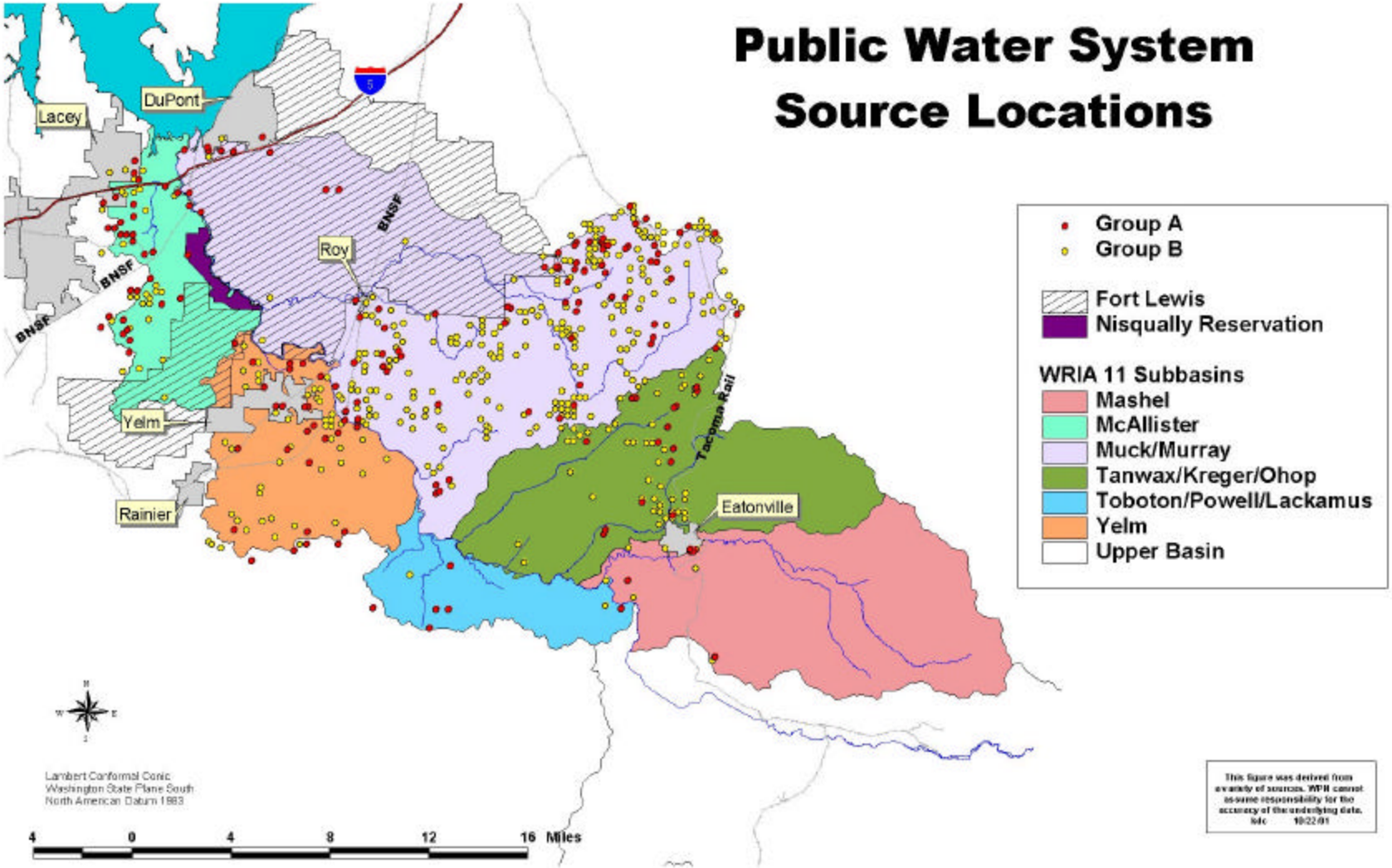


Figure 5.3-8: Lower Nisqually Basin (WRIA 11) – Public Water Systems

Public Water System Water Use

Residential water use and return flow assumptions developed previously can be applied to public water systems for estimating water use in this sector (Table 5.3-12). The City of Lacey's public water system in the McAllister subbasin is apparently the only system that has a sewer service that exports from the basin. The City of Yelm and the Town of Eatonville also have sewer systems but return flows occur within the respective subbasin. Those sewered connections that export represent a 100% net depletion for in-house use and an estimated 43% depletion associated with outdoor use (Solly et al, 1993).

An estimate of the average and maximum day demand of all public water systems was 10.9 cfs and 21.8 cfs, respectively. The net depletion, assuming all septic systems, was roughly 1.4 cfs and 6.1 cfs. Public water system water use represents 78% of the basin-wide residential water use.

Table 5.3-11: Estimated Current Residential Water Use Supplied by Public Water Systems (PWS)

Subbasin Name	Sub-basin Year 2000 Population served by PWS	Average Per Capita Water Demand (gcd)	Maximum Per Capita Water Demand (gcd)	Year 2000 Average Day Demand [ADD] (cfs)	Year 2000 Max Day Demand [MDD] (cfs)
McAllister	12,030	148	296	2.76	5.51
Muck/Murray	20,355	153	306	4.82	9.64
Yelm	7,186	151	302	1.68	3.36
Toboton/Powell/ Lackamus	1,327	157	314	0.32	0.64
Tanwax/Kreger/ Ohop	972	143	286	0.22	0.43
Mashel	2,162	119	238	0.40	0.80
TOTAL	44,032			10.91	21.81

EXEMPT WELLS

Based on the public water system summary, the remaining 28% of the residential population is self-supplied, covered either by domestic water rights or under exempt well status. The potential for cumulative effects from water withdrawals under the exempt well status has been controversial in the watershed planning projects under ESHB 2514.

According to the law (RCW 90.44.050), certain small-scale water uses are provided an exemption from the requirement to obtain a permit/water right as follows:

"…any withdrawal of public ground waters for stock-watering purposes, or for the watering of a lawn or of a noncommercial garden not exceeding one-half acre in area, or for single or group domestic uses in an amount not exceeding five thousand gallons a day, or for an industrial purpose in an amount not exceeding five thousand gallons a day, is and shall be exempt from the provisions of this section…"

Exempt wells are most often constructed for single or multiple domestic purposes. While exempt ground water withdrawals have been assigned a rate of withdrawal, they have not been assigned an annual volume limit, which leads to the assumption that water can be withdrawn at the indicated rate year-round. Water rights issued for domestic purposes since the 1960s have been assigned a rate of diversion/withdrawal and an annual volume limit. The lack of an annual volume limit associated with exempt wells has resulted in significant residential development statewide for which reliance on the full rate of 5,000 gallons per day has occurred. For example, certain development interests have constructed exempt wells and then proceeded to build six houses, commonly known as "six packs." These six packs likely will use the full rate of 5,000 gallons per day yet a single-family home is less likely to use that full rate. The implementation of six packs as well as the cumulative effect of numerous exempt wells pose the potential for greater use of ground water and, therefore, greater impact on the system. The statute does not explicitly allow for "six-packs" however the law currently restricts the use to one well per development. The Department of Health requires a maximum day demand of 800 gallons per dwelling unit for lots in excess of one acre thus restricting the exempt wells to serving no more than six homes. At this time, no metering is required of such wells.

While it is difficult to arrive at an accurate number of wells, two different approaches can be used to provide an estimate of water use by exempt wells: 1) population data basis or 2) land parcel data basis. The latter being more detailed and, therefore, more costly was beyond the scope of the Level 1 Assessment. In this document, a population estimate of water users withdrawing from exempt wells was determined at the sub-basin level. In some subbasins in which numerous multiple domestic rights exist, it was only possible to estimate the population under the multiple domestic rights and under exempt wells because often the number of units served by multiple domestic rights is not reported in the WRATS database.

The population for the entire Lower Nisqually Basin was 60,773 while the public water systems serve a total of 44,032. About 4,100 people are served under a single domestic water right. The remaining 12,641 people were self-supplied either under a multiple domestic right that was not a public water system or under an exempt well. This sector uses roughly 2.8 cfs with a net depletion of 0.4 cfs (return flow = 2.4 cfs) in the winter and 5.6 cfs in summer with return flow of 209 gcd or 4.0 cfs, 1.6 cfs net impact on the surface/ground water system.

IRRIGATION

The Census of Agriculture summarizes agricultural data by county every five years including some statistics on irrigated land. The USGS has reported water use information by WRIA and by county once every five years, as well. However, these data will no longer be summarized by WRIA. Little or no information is available that details the spatial distribution of irrigated agriculture in the Lower Nisqually Basin.

The Census of Agriculture reported that there were 5,564 irrigated acres of land in Thurston County in 1997 from which 3,968 acres were harvested for cash crops and 1,596 acres were in pasture (USDA, 1999). The Census of Agriculture also reported the 5,149 irrigated acres in Pierce County; 4,120 acres in cash crops and 1,029 acres in pasture.

The USGS reported irrigated land in 1995 for WRIA 11 was 1,270 acres; 1,180 irrigated by a sprinkler method and 90 acres irrigated by microirrigation (also known as trickle or drip irrigation) (USGS, 1995). USGS also reported the irrigation water use: 4.6 acre-feet per day from ground water and 2.6 acre-feet per day of surface water for a total of 7.27 acre-feet/day. (http://water.usgs.gov/watuse/)

Given the 1995 USGS estimate of 1,270 irrigated acres, actual use appears to be much less than the allocation since the irrigation water rights covered 8,798 acres of land for an annual volume of irrigation water of more than 16,400 acre-feet. Actual use appears to be on the order of 14% of the water righted acreage based on the 1995 USGS Water Use Data. From discussions with NRCS in Thurston County (Swotek, 2001), about 60% of the pasture grass in the basin is irrigated along with various row crops such as corn, squash, strawberries, raspberries and other organic farm crops. Raspberry plants for transplant are a major crop in the basin. Some of the pasture grass is grazed and a portion of it is hayed. Three large landowners own most of the irrigated acres in pasture

grass. In addition, most of the irrigated agriculture tends to be in the McAllister subbasin (Thurston County).

The Farm Service Agency (Modin, 2001) provided information for Pierce County agriculture. Irrigated crops include lettuce, strawberries, raspberries, peppers, squash, hay, and some field and sweet corn. Lettuce was the largest irrigated crop followed by squash, which includes pumpkin, zucchini, and summer and winter squash. Most of the agriculture in the Pierce County portion of the lower Nisqually Basin occurs in the Muck/Murray Subbasin.

Crop consumptive use, the amount of water a crop directly needs, can be calculated using several different empirical methods. Irrigation requirements for Washington (James et. al, 1989) advocate the use of a modified Blaney-Criddle method, a temperature-based method. Doorenbos and Pruitt's (James et. al., 1989) adaptation of the Blaney-Criddle method is based on data from a wide-range of climates and crop coefficients for a wide range of crops, both of which are useful in Washington. A detailed description of this method is beyond the scope of this document, however, for purposes of understanding irrigation water use, certain data that were developed from the Doorenbos and Pruitt Blaney-Criddle method were selected to demonstrate the monthly variability of crop water requirements.

Pasture grass was used to assess crop irrigation requirements since this crop tends to have the highest in consumptive use relative to other crops; field corn was also noted (Table 5.3-14) for purposes of comparison with a less consumptive crop. The seasonal variation of temperature, and crop consumptive use for pasture grass in Olympia are shown (Figure 5.3-9) along with a comparison of the irrigation requirements for both the water right acres and an estimate of actual use irrigated acres. Climate data for Olympia can be used for Thurston County subbasins, and Puyallup climate data can be applied to subbasins in Pierce County. The key factors in this table are the crop consumptive use (CU), effective precipitation (P_{eff}), and the crop irrigation requirements (CIR):

$$\mathbf{CIR = CU - P_{eff}}$$

The effective precipitation is a function of the precipitation and reference crop evapotranspiration (ET) and was calculated for each month by the NRCS (updates to WAIG, 1992). While McMillan Reservoir may be more representative of Pierce County and average monthly data are easy to summarize, calculating the reference crop ET and the effective precipitation for that location is beyond the scope of this level 1 assessment.

On-farm efficiency can be defined as that portion of the delivered water that is actually used by the crop. In other words, an efficiency of 70% means that 30% more water must be withdrawn than that actually used by the crop. This takes into account on-farm losses, ditch conveyance losses, and deep percolation to ground water. Table 5.3-13 displays some typical on-farm efficiencies. According to the USGS, most of the irrigation is either by sprinkler. The return flow from sprinkler irrigation is an estimated 30% according to the Cooperative Extension Service (WSU, 1989). An efficiency of 70% was used to develop an estimate of return flow from farms in the Lower Nisqually Basin.

Table 5.3-12: Typical on-farm efficiencies for various types of irrigation systems

System	Efficiency
Surface:	
Average system, no treatment	50%
Partial treatment, i.e. land leveling or irrigation pipelines etc.	60%
Land leveling, delivery pipeline, and drainage system meeting design standards	70%
Tailwater recovery system with proper land leveling, delivery pipeline, and drainage system	85%
Sprinkler	**60 – 75%**
Trickle	85 – 90%

Source: From Report on the Water Conservation Study, U.S. Dept of Interior, Bureau of Reclamation and Bureau of Indian Affairs, 1978.

Figure 5.3-8 illustrates the different pathways of water use after it has been withdrawn from a system. The percentages are based on irrigated agriculture nationwide. However, the diagram provides a good demonstration of the different physical mechanisms that take place from an agricultural diversion.

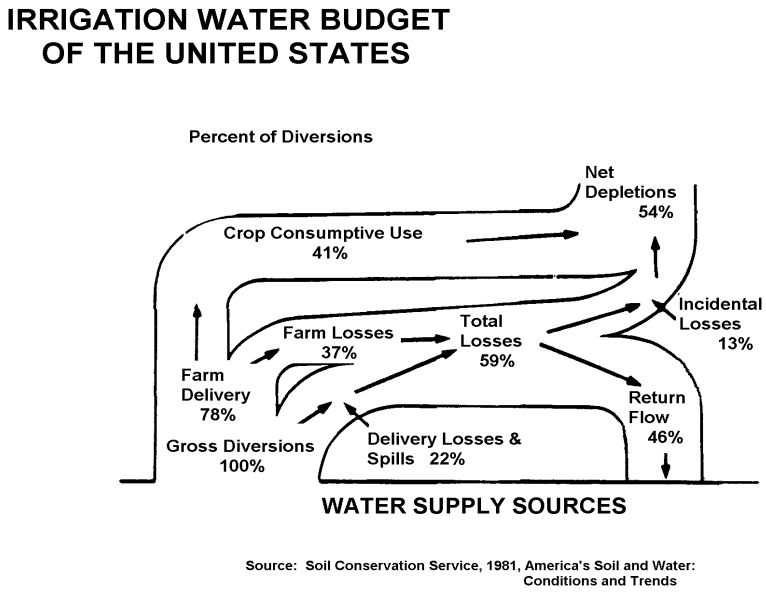


Figure 5.3-9: U.S. Irrigation Water Budget

Table 5.3-13: Lower Nisqually Basin (WRIA 11) – Crop Consumptive Use and Irrigation Water Requirements

Olympia		**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Mean Temp	°F	50.1	42.9	38.8	37.4	40.8	43.2	47.5	53.5	58.8	63	63	58.1	
Total Precip	in	4.75	8	8.39	7.89	5.97	5.07	3.15	1.94	1.53	0.79	1.2	2.26	50.94
Reference Crop ET	in	1.44	0.26	0	0.02	0.53	1.19	2.64	3.92	4.71	5.89	4.55	3.56	28.71
Effective Precip	in	1.41	0.26	0	0.02	0.53	1.17	1.98	1.37	1.12	0.62	0.87	1.58	10.93
Pasture/Turf														
Crop Irr Reqmnt	in	0	0	0	0	0	0	0.53	2.36	3.35	4.97	3.45	1.81	16.47
Consumptive Use	in	1.37	0.25	0	0	0	1.06	2.51	3.72	4.47	5.6	4.32	3.38	26.68
Irr Reqmnt Eff=70%		0.00	0.00	0.00	0.00	0.00	0.00	0.76	3.37	4.79	7.10	4.93	2.59	23.53
Field Corn														
Crop Irr Reqmnt	in	0.00	0	0	0	0	0	0	0	1.26	4.29	4.13	2.13	11.81
Consumptive Use	in	1.01	0	0	0	0	0	0	0.12	2.4	4.89	5.01	3.7	17.13
Irr Reqmnt Eff=70%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80	6.13	5.90	3.04	16.87

Puyallup		**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Mean Temp	°F	51.8	44	40.2	38.9	42	44.9	49.5	55.4	60.2	64.1	63.8	59.1	
Total Precip	in	3.59	5.68	6.32	5.58	4.54	4.03	2.72	1.95	1.75	0.82	1.12	1.98	40.08
Reference Crop ET	in	1.54	0.3	0	0.09	0.59	1.3	2.84	4.14	4.88	6.04	4.64	3.66	30.02
Effective Precip	in	1.52	0.3	0	0.09	0.59	1.28	1.78	1.38	1.27	0.65	0.81	1.38	11.05
Pasture/Turf														
Crop Irr Reqmnt	in	0	0	0	0	0	0	0.92	2.55	3.36	5.09	3.6	2.09	17.61
Consumptive Use	in	1.46	0.29	0	0	0.24	1.23	2.7	3.93	4.64	5.74	4.41	3.48	28.12
Irr Reqmnt Eff=70%		0.00	0.00	0.00	0.00	0.00	0.00	1.31	3.64	4.80	7.27	5.14	2.99	25.16
Field Corn														
Crop Irr Reqmnt	in	0	0	0	0	0	0	0	0	1.15	4.37	4.29	2.42	12.23
Consumptive Use	in	1.08	0	0	0	0	0	0	0.13	2.44	5.01	5.1	3.81	17.57
Irr Reqmnt Eff=70%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	6.24	6.13	3.46	17.47

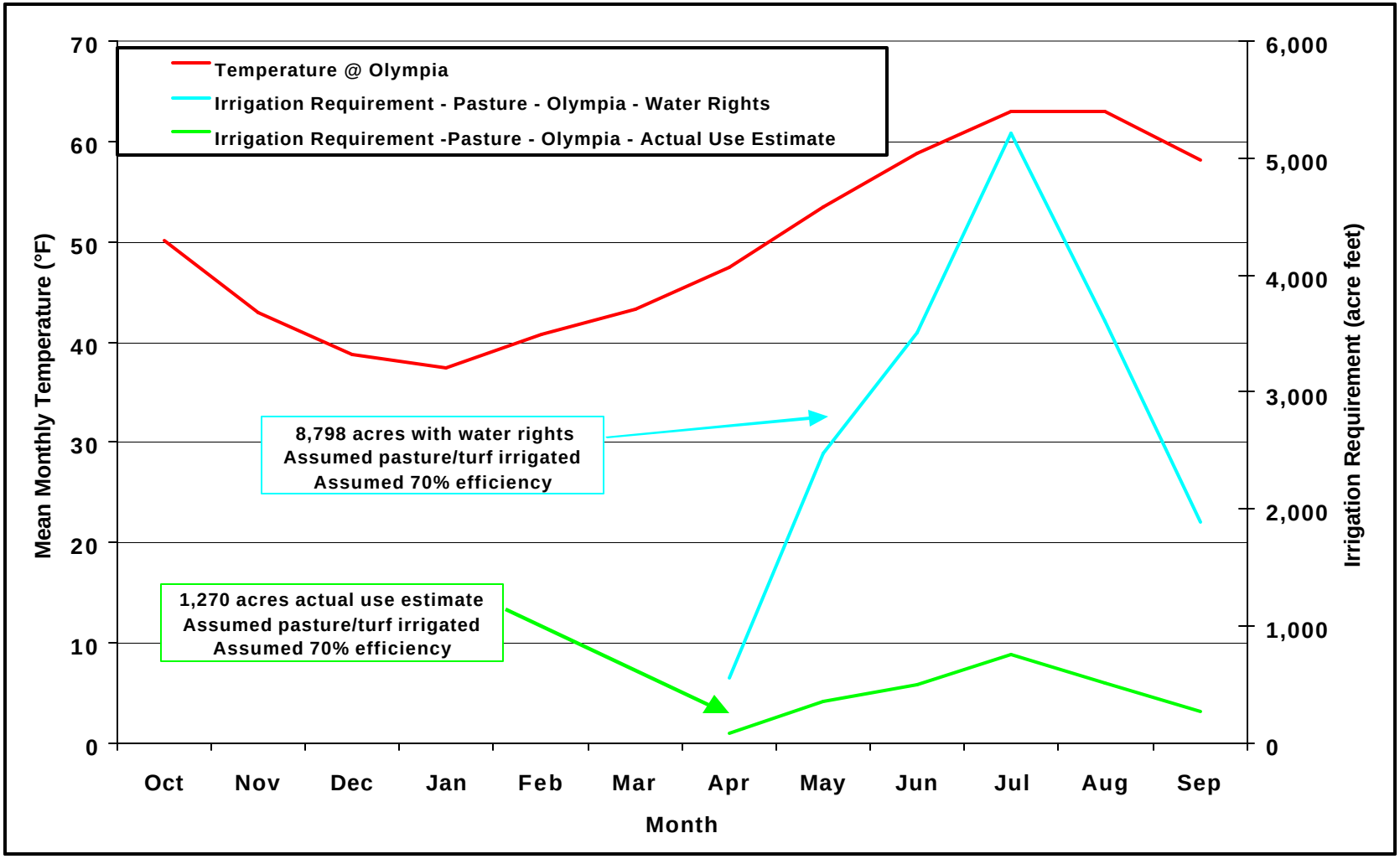


Figure 5.3-10: Lower Nisqually Basin (WRIA 11) - Monthly Irrigation Requirements for Water Right Acres and Estimate of Actual Use Acres (USGS, 1995). Source: Washington State Irrigation Guide, 1994.

Given the order of magnitude difference in the allocated and potentially irrigated acreage, investigation into the actual use of irrigation water may be a worthwhile effort. As irrigated lands decline and the fact that there appears to be substantially less irrigation than the acreage allocated under water rights suggests, it would be useful to know which water rights were actually being used and which ones were not. Because irrigation represents such a high consumptive use of water, this effort may be worth the time and cost to sort out in a Level 2 Assessment; however, success would require cooperation of the farmers.

COMPARISON OF STREAMFLOW AND ALLOCATED WATER

One of the key issues to be addressed in this assessment is the physical and legal availability of water. This concept brings together the components of water allocation, water use, hydraulic continuity, and streamflow.

For each subbasin, allocated water was compared to streamflow in two different ways. First, the total allocated water as diversion/withdrawal rates was compared to the streamflow to provide an overview of the water quantity situation. This comparison approach assumes that the water rights are used to their full entitlement (based on the diversion rate not volume) and that the groundwater rights are in 100% continuity with the streamflow (except where noted). Another perspective is provided by distributing the water righted volume limitations throughout the year and accounting for net depletions assuming the water right limits represent water use. To estimate depletions associated with the water right annual volume limits, similar assumptions were used as defined in previous sections.

Assumptions:

- Winter season use accounts for 33% of the total annual volume
- Winter depletions from residential use was about 13%
- Summer season use accounts for 67% of the total annual volume
- Summer depletion from residential use was about 28%
- No irrigation occurs from October through April
- For irrigation of crops, a net depletion of 43% was used based on the reported 57% return flow estimate from the USGS (Solly et.al., 1993).
- Depletions from stock watering were roughly 87% (Solly et.al., 1993)

Table 5.3-14: Depletions from Water Rights for Subbasins tributary to the Lower Nisqually Gage

Use Sector	Annual Limits (acre-feet)	Depletion Winter (acre-feet)	Depletion Winter (cfs)	Depletion Summer (acre-feet)	Depletion Summer (cfs)
Commercial[1]	73	4.8	0.01	9.8	0.032
Multiple domestic	3,256	139.7	0.33	610.8	2.013
Single Domestic	272	11.6	0.03	50.9	0.168
Irrigation	10,006	0	0.00	4302	14.177
Municipal – (in-of-basin)	1204	51.7	0.12	202.3	0.667
Municipal – (out-of-basin)	0	0	0.00	0	0.000
Stock (87% depletion)[1]	1020	515.42	1.23	371.98	1.226
Other (non-consumptive)	361	0	0.00	0	0
Total	**16,191**	**718**	**1.71**	**5,538**	**18.25**
[1]Solly et.al., 1993					

Note: The values calculated in Table 5.3-15 are not carried to the 2nd or 3rd decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, some would be reported as zero. Also keep in mind that in the case where more than one use was identified with a right, the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis solely for the purpose of demonstrating the magnitude of depletions and should not be misconstrued as entirely accurate.

The exceedance streamflows were taken from Chapter 5.1: Streamflow. For the lower Nisqually, flows were derived from the combined 12089208: Centralia Power Canal Nr Mckenna, and 12089500: Nisqually River At Mckenna. The subbasins of Yelm, Toboton/Powell/Lackamus, Tanwax/Kreger/Ohop, Mashel, and the Horn/Murray portion of Muck drain above the point where the power canal returns to the mainstem Nisqually River. The depletions from these subbasins were added together and used to compare to the exceedance flows and the depletions (Figure 5.3-10). The instream flow alone is less than or equal to the 90% exceedance streamflow in August and September. Any depletions above that exacerbate that situation. The depletions combined with the instream flow present a problem in October. Instream flows and depletions are met at the 50% exceedance level for streamflow.

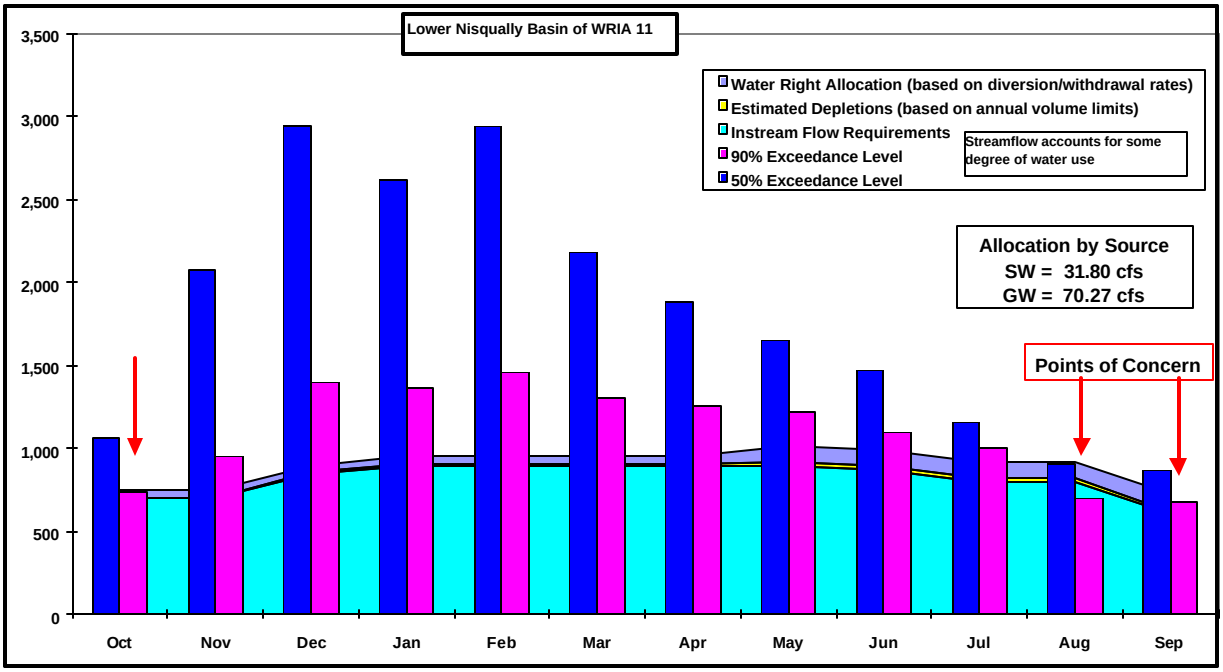


Figure 5.3-11: Lower Nisqually Basin of WRIA 11 - Depleted Streamflow vs. Water Allocation & Estimated Depletions from Ground and Surface Water Rights from Mashel, Tanwax/Kreger/Ohop, Toboton/Powell/Lackamus, Yelm, and Horn/Murray areas tributary to gaging station.

SUBBASIN SUMMARIES AND FINDINGS

MCALLISTER

Water Rights

Based on the WRIA 11 and WRIA 13 WRATS database, the McAllister Subbasin provides the source of supply for 14 municipal and 37 multiple domestic water right certificates and 3 municipal and 1 multiple domestic permits. The 31,231 acre-feet annual volume under the municipal rights by far exceed the annual volume of any other use sector. The multiple domestic rights are entitled to use a combined 1,183 acre-feet per year. The water rights in the McAllister subbasin represent, by volume, 62% of all the consumptive water allocated in the Lower Nisqually Basin. This is primarily due to the significant municipal rights with the assumed large annual volume limits.

The City of Olympia has three certificates, one permit, and one application in the water rights database. Change applications have been submitted to WDOE for S2-01105, S2-*05325CWRIS, and S2-10191 to withdraw water from ground water wells rather than the current point of withdrawal from McAllister Springs. To date, these changes have not

been issued. In addition, the City has applied for an application for an amount equivalent to the first two rights (19.6 MGD) in the event that the change requests are viewed as a different water source from the original rights (Walsh [WDOE], 2001). According to the City of Olympia (Decillo, 2001), the permit (S2-10191) is intended to withdraw water from Abbot Springs. Apparently this right has not yet been put to beneficial use.

Although annual volume limits were not assigned to Olympia's surface water rights, the City assumes their entitlement is the full use of the water rights year round (Micheau, 2001). Based on this assumption, the annual volume limit for the 25 cfs certificate was estimated at 18,068 acre-feet while the 10 cfs permit was 7,227 acre-feet.

Table 5.3-15: City of Olympia's water rights located within McAllister Subbasin.

Control Number	Old Certificate Number	Withdrawal Rate	Annual Volume Limit (Acre-feet)	Volume (MGD)	Source
S2-01105		5.33 cfs	3870	3.45	McAllister Springs
S2*-05325CWRIS	08030	25.00 cfs	Not assigned	16.16	McAllister Spgs
G2-27631CWRIS		23.00 gpm	2.5	.03	Well
S2-10191	Permit	10.00 cfs	Not assigned	6.46	McAllister Creek
G2-29900	Application	13,600 gpm	Not assigned	19.6	Well

The City of Lacey has 14 different water rights for their water sources within the McAllister Subbasin. All but three of these rights were found in the WRIA 13 WRATS database. The total annual volume the City of Lacey can withdraw under these rights is 2,033.8 acre-feet. Five of these rights are supplemental and the annual volume limits are restricted within the limits of the primary water right. The City of Lacey also has applications pending for four ground water rights totaling 8,450 gpm.

Table 5.3-16: City of Lacey's water right certificates

Control Number	Old Certificate Number	Withdrawal Rate (gpm)	Annual Volume Limit		Comments
			Primary (Acre-feet)	Supplemental (Acre-feet)	
McAllister Well Field					
G2-26685P		300	157		In database as CG2-26685P
CG2-23743		500		400	Supplemental – Also in database as CG2-23743P
Madrona Well Field					
G2-*01807C	1288	55	30		
G2-*03324C	1777	300	432		
G2-*04274CWRIS	3718	350	112		Thurston Cty Water District #2
G2-*05186C	3654	283	452.8		
G2-20879		300		160	Supplemental
G2-25778B		500		403.25	Supplemental
G2-20878		200		107	Supplemental – In database as CG2-20878
G2-*05663C	3823A	300	480		In WRIA 13 database as 3823
G2-*09318C*	6320	150	108		
G2-26623B*		440	132		In database as CG2-26623B for 1500 gpm & 180 af
Meridian Acres Well					
G2-25802C		250	130		In WRATS under M&R Construction
S-12 Well					
G2-20883CWRIS*		700		374	
Totals			**2,033.8**		

*These rights were found in the WRIA 11 WRATS database and subsequently plotted in Figure 5.3-11; all other rights in this table were found in WRIA 13 WRATS database and not plotted.

The water right certificates in the subbasin cover 2,383 acres for irrigation purposes. The extent to which these are actually being irrigated is unknown. More irrigation occurs in the McAllister subbasin than in the other Thurston County subbasins of Yelm and Toboton/Powell/Lackamus (Swotek, 2001).

There are three fisheries production rights for a total in-channel flow of 47 cfs. These are non-consumptive rights and should not cause any depletion to the streamflow. One power right for 2.50 cfs is also a non-consumptive right.

Water right volume limits were aggregated by section and spatially displayed for ease in understanding the general distribution of rights in this subbasin (Figure 5.3-12).

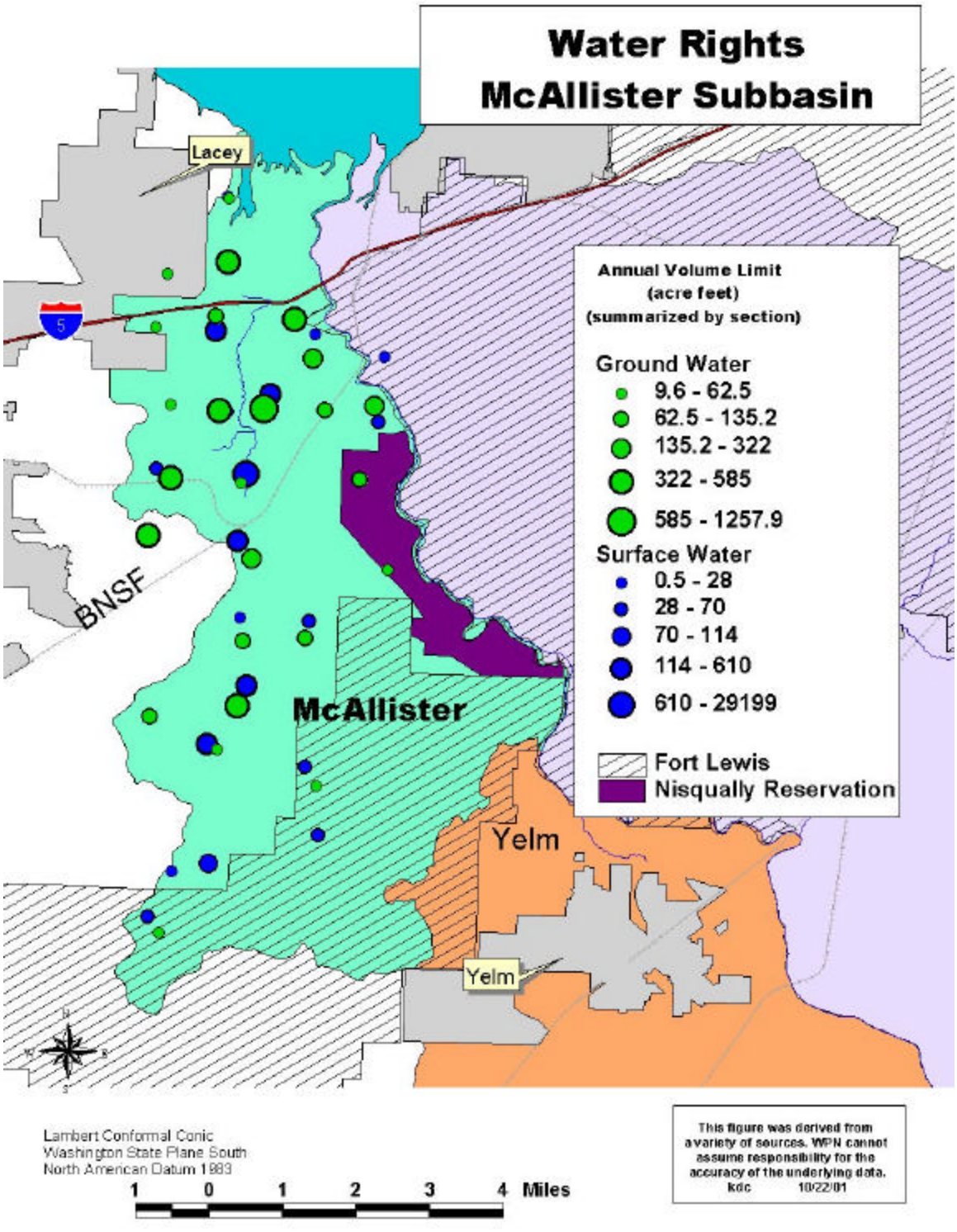


Figure 5.3-12: McAllister Subbasin – Water Rights Summary by Volume (acre-feet) [Does not include the water rights applications or certificates for the City of Lacey that were listed in the WRIA 13 database.

Table 5.3-17: McAllister Subbasin –Summary of Water Rights By Primary Beneficial Use

Primary Beneficial Use	All Certificates					Ground Water Certificates				Surface Water Certificates			
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres
Commercial/Industria	4	0.67	335	554	0	3	335	64	0	1	0.67	490	0
Multiple Domestic	37	0.06	2,948	1,125	0	35	2,948	1,122	0	2	0.06	3	0
Single Domestic	52	0.62	123	40	2	9	123	9	0	43	0.62	32	2
Fire Protection	1	1.00	0	1	0					1	1.00	1	0
Fish Propagation	3	47.00	900	841	0	1	900	840	0	2	47.00	1	0
Irrigation	64	9.83	5,208	3,755	1,887	24	5,208	1,721	866	40	9.83	2,034	1,021
Municipal	14	30.33	3,888	23,715	0	12	3,888	1,745	0	2	30.33	21,970	0
Power	1	2.50	0	0	0					1	3	0	0
Stock	11	1.12	2,609	733	394	9	2,609	681	369	2	1.12	52	25
Wildlife	2	0.00	450	505	100	2	450	505	100				
Totals:	**189**	**93.13**	**16,461**	**31,268**	**2,383**	**95**	**16,461**	**6,686**	**1,335**	**94**	**93.13**	**24,582**	**1,048**

Primary Beneficial Use	All Permits					Ground Water Permits				Surface Water Permits			
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres
Multiple Domestic	1		175	58	0	1	175	58	0				
Single Domestic	1	0.02		0	0					1	0.02	0	0
Municipal	3	10.00	740	7,516	0	2	740	289	0	1	10.00	7,227	0
Totals:	**5**	**10.02**	**915**	**7,574**	**0**	**3**	**915**	**347**	**0**	**2**	**10.02**	**7,227**	**0**

Primary Beneficial Uses	All Applications					Ground Water Applications				Surface Water Applications			
		Instantaneous Flow Rates		Annual Volume	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume	Potentially Irrigated
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres
Multiple Domestic	3	0.00	159	0	0	3	159						
Single Domestic	3	0.05	0	0	0					3	0.05		
Municipal	5	0.00	22,050	0	0	5	22,050						
Irrigation	1	0.00	60	0	4	1	60		4				
Stock	1	0.00	80	0	3	1	80		3				
Totals:	**13**	**0.05**	**22,349**	**0**	**7**	**10**	**22,349**	**0**	**7**	**3**	**0.05**	**0**	**0**

TOTAL:	**207**	**103.20**	**39,725**	**38,842**	**2,389**	**108**	**39,725**	**7,033**	**1,341**	**99**	**103.20**	**31,809**	**1,048**

Includes City of Lacey water rights found in WRIA 13 database.

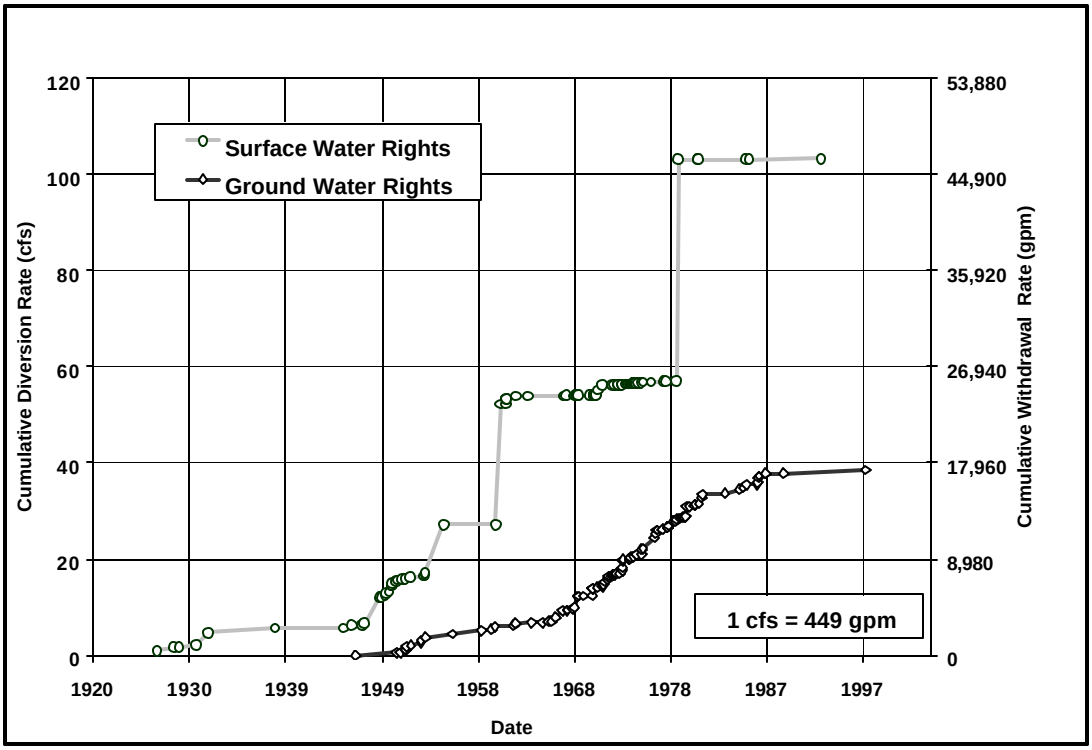


Figure 5.3-13: McAllister Subbasin –Water Allocate d Over Time

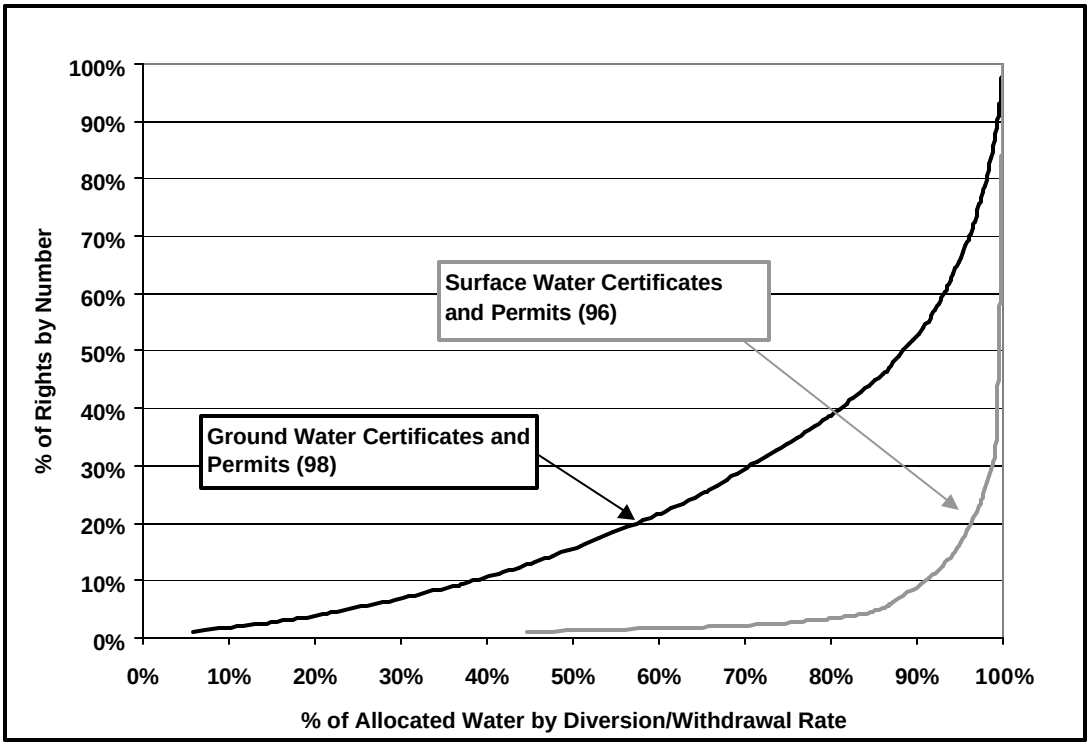


Figure 5.3-14: McAllister Subbasin – Percent of Rights Covering Percent Allocated Water

Because of the large surface water rights, 9% of the rights cover 90% of the diversion allocation. By contrast, 53% of the ground water rights cover 90% of the ground water withdrawal rate; 16% of the rights cover 50% of the allocation. In other words, if further studies were conducted concerning water use and allocation, 90% of the allocated water would be addressed if 9 surface water rights and 52 ground water rights were examined in detail (Figure 5.3-13).

The ground water rights in the McAllister subbasin are small compared to the surface water rights. One fisheries right and two municipal rights are shown as sharp increases in the surface water line (Figure 5.3-14). Allocations in surface water since 1979 have been small relative to the four large rights. From 1965 to 1980, ground water allocation has consistently increased. Since about 1985, these allocations have been smaller in size.

By diversion rate, the fisheries and municipal rights are the largest (Figure 5.3-15) yet the municipal rights are consumptive rights and, therefore, a very large annual volume limitation is shown (Figure 5.3-16). Other primary beneficial uses appear small compared to these two sectors.

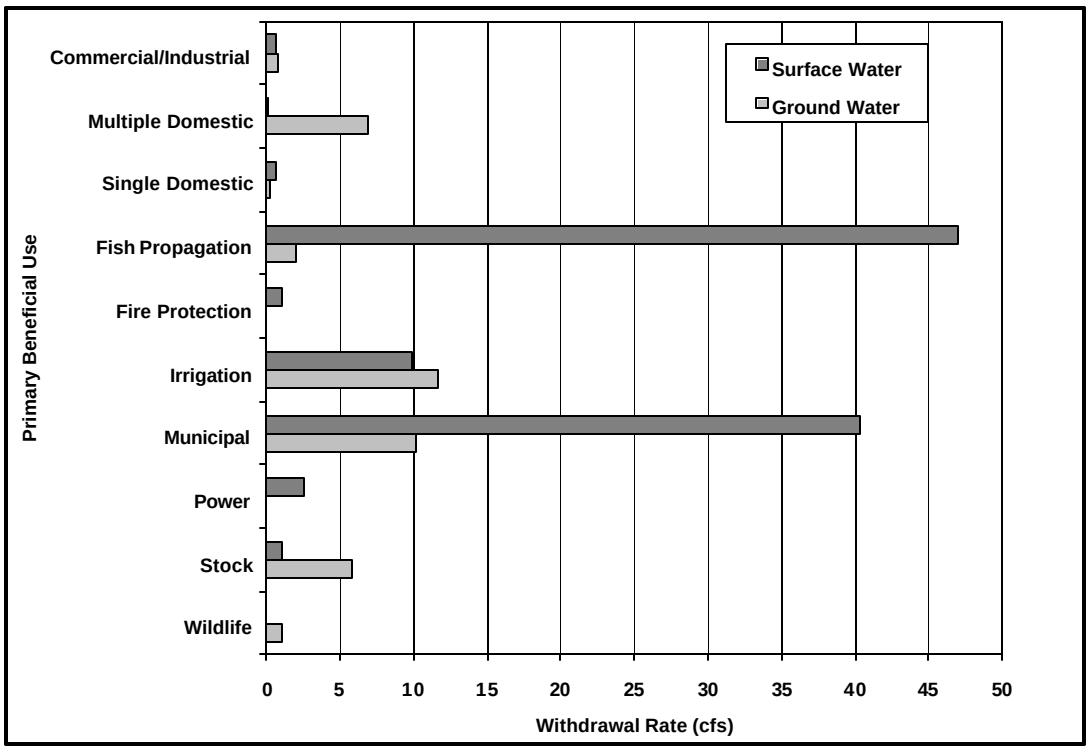


Figure 5.3-15: McAllister Subbasin – Allocated Diversion/Withdrawal Rates by Primary Beneficial Use (cfs)

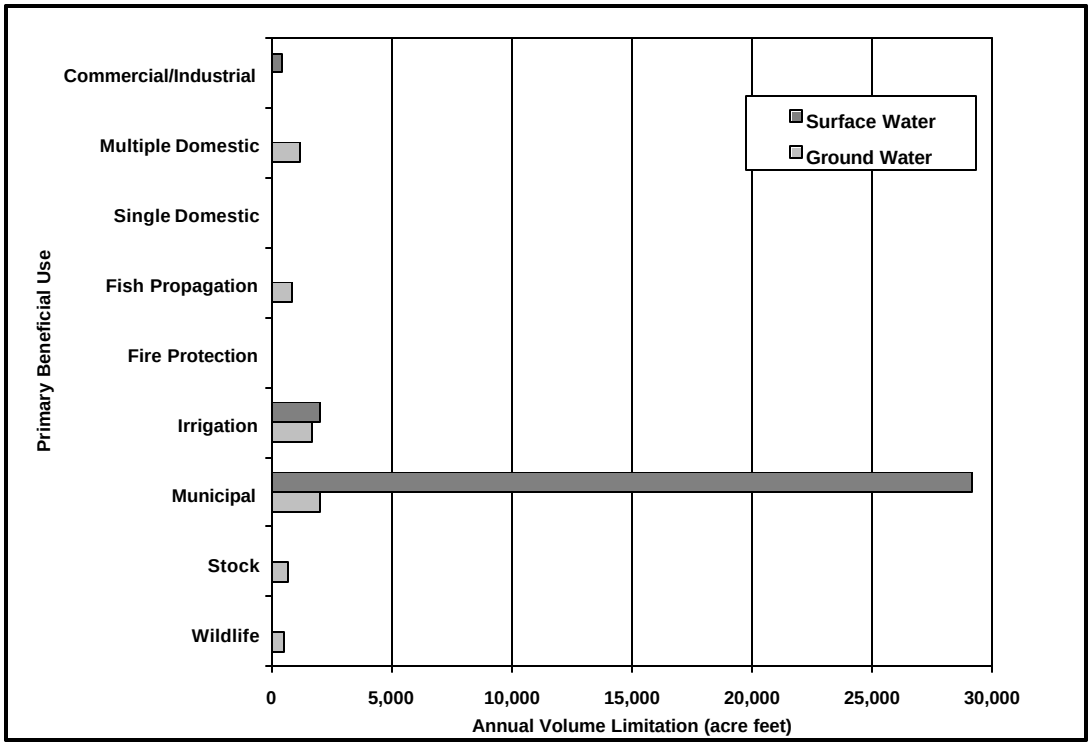


Figure 5.3-16: McAllister Subbasin – Allocated Volume Limits by Primary Beneficial Use (acre-feet)

Water Use

Current Residential Water Use

As noted in the *Residential Water Use* section for the Lower Nisqually, the McAllister population from the 2000 census was estimated at 13,590. Based on the estimated average day demand of 148 gcd and the maximum day demand of 296 gcd, the winter season residential demand for this subbasin was approximately 3.1 cfs and the summer season demand was 6.2 cfs. The maximum net depletion to the system from residential water use was estimated at 0.82 cfs and 1.64 cfs, respectively. This accounts for the in-basin water use and the out-of-basin sewage exports by City of Lacey customers.

The large surface water rights for municipal use, noted in the *Water Rights* section above, are held by the City of Olympia, and would constitute 100% depletion to the system since the entire service area is outside of the McAllister subbasin and all of Lower Nisqually Basin (WRIA 11).

The City of Lacey has numerous ground water wells in the basin and with the exception of the supply for the in-basin Lacey population, the City's water is also a 100% depletion to the basin. The City of Lacey serves about 5,200 people in the McAllister Subbasin; 60% are connected to a sewer system and 40% are on septic systems. Return flow to the basin occurs from both in-house and outside water use while the sewered systems contribute return flow via outside water use only.

Public Water Systems

The McAllister subbasin is the source of water supply for 63 public water systems serving 12,030 people. Of these, there are 28 Group A Public Water Systems serving 11,606 people with 4,827 residential connections and 455 non-residential connections. The five largest Group A systems serve a total population of 9,962 with 3,939 residential connections. The largest five Group A systems represent 83% of the subbasin population and 82% of the residential connections served by all Group A systems (Table 5.3- 18).

There are 35 Group B Public Water Systems, serving 423 people, 164 residential connections, and 9 non-residential connections. The largest of the Group B systems serves 24 people with 6 residential connections.

Table 5.3-18: McAllister Subbasin – 5 Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections
Lacey Water Department[1]	5,200	2,080	15	2095
Meadows Water System	2,070	783	1	784
Pattison	1,671	668	0	668
Holiday Ranchettes	538	215	0	215
Rolling Firs Evergreen Terrace	483	193	0	193
Total	**9,962**	**3,939**	**16**	**3,955**

[1]Data within McAllister Subbasin provided by Rector (2001) personal communication.
Source: Washington Department of Health, 2001

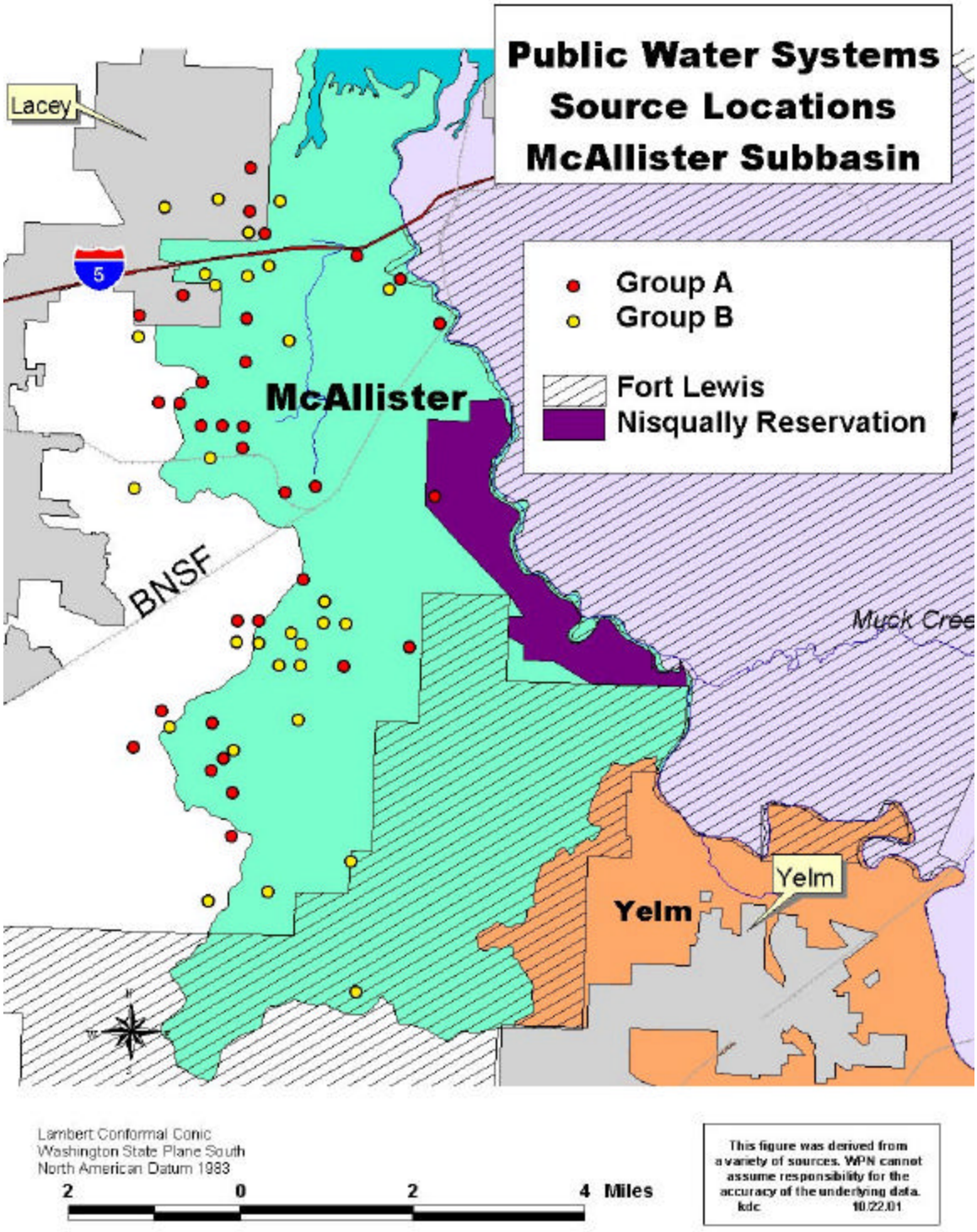


Figure 5.3-17: McAllister Subbasin – Public Water System Summary by Source Location

Exempt Wells

As noted earlier, exempt wells can be estimated by a process of elimination. The population in the McAllister subbasin is currently estimated at 13,590. Of those, 12,030 are served under a public water system. There were 53 domestic rights for single-family use, leaving 1,428 people that are self-supplied either under a multiple domestic right or an exempt well. If the multiple domestic rights were sorted out as to which ones are associated with a public water system and which ones are not as well as identify the number of housing units are assigned to each right, a closer estimate of exempt wells could be ascertained. This step is beyond the scope of the Level 1 assessment.

Comparison of Streamflow and Allocated Water

The McAllister Subbasin has significant water rights from both ground and surface water, 103.15 cfs and 17,376 gpm (38.70 cfs), respectively. The comparison of the combined diversion/withdrawal rates for certificates and permits (141.85 cfs) show substantially more allocation than streamflow. However, when comparing the depletions (Table 5.3-19) from these same rights, the effect is most significant in the months of July, August, and September at the 90% exceedance level (Figure 5.3-17). The degree of hydraulic continuity of the ground water rights will determine the extent of the effect on the surface water system.

City of Olympia has 40.33 cfs of surface water rights from McAllister Springs and McAllister Creek according to the WDOE database. These rights constitute 100% depletion to the system since Olympia is located outside of the WRIA. All three have change requests from 1995 on file for to change to a ground water source from a nearby well field. These rights are listed as municipal out of basin use (Table 5.3-15). The out-of-basin transfer by the City of Olympia can be as much as 29,200 acre-feet per year of surface water. The City of Lacey can annually withdraw up to 2033.8 acre-feet to meet their water demand; the Lacey rights use ground water as the source of supply.

In the McAllister subbasin, the portion that drains to the Nisqually River represents 28% of the whole subbasin while 72% of the area is drained by McAllister Creek (See Chapter 5.1: Streamflow). Nine of the water rights were situated within the Nisqually portion of the subbasin (<5% of all McAllister rights). The Nisqually rights in the McAllister Subbasin allow diversions/withdrawals of 476 acre-feet/year at a rate of 0.42 cfs through surface water diversions, and 1,640 gpm (3.65 cfs) through ground water

withdrawals. The water rights in the Nisqually River drainage were subtracted out of the total volumes and rates to understand the net depletions to the stream (Table 5.3-19).

The depletions were developed based on the assumptions that:

- Winter season use accounts for 33% of the total annual volume
- Winter depletions from residential use was about 13%
- Summer season use accounts for 67% of the total annual volume
- Summer depletion from residential use was about 28%
- No irrigation occurs from October through April
- For irrigation of crops, a net depletion of 43% was used based on the reported 57% return flow estimate from the USGS (Solly et.al., 1993).

Table 5.3-19: McAllister Subbasin –Ground and Surface Water Right Depletions Based on Annual Volume Limits within the McAllister Creek drainage.

Use Sector	Annual Limits (Acre-feet)	Depletion Winter (Acre-feet)	Depletion Winter (cfs)	Depletion Summer (Acre-feet)	Depletion Summer (cfs)
Commercial[1] (20% consumptive use)	554	37	0.09	74	0.24
Multiple domestic[2]	1,140	49	0.12	214	0.70
Single Domestic	40	2	0.00	8	0.02
Irrigation[2]	4,284	-	-	1,842	6.07
Municipal – (in-of-basin)	-	-	-	-	-
Municipal – (out-of-basin)					
City of Lacey	2,034	1,181	2.81	853	2.81
City of Olympia	29,200	16,960	40.34	12,240	40.34
Stock (87% consumptive use)[1,2]	11	3	0.01	2	0.01
Other (non-consumptive)	1,147	-	-	-	-
Total	**38,410**	**18,232**	**43.37**	**15,232**	**50.20**

[1]Solly et.al., 1993 Winter = October through April, Summer = May through September

[2]Nine rights subtracted due to source of right tributary to Nisqually River not McAllister Creek

Note: The values calculated in Table 5.3-18 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be

reported as zero. Also keep in mind that in the case where more than one use was identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

The streamflow used to compare to water right diversion/withdrawal rates and associated depletions was the gaged flow at McAllister Springs ((#12-081500). This gage is not representative of natural flow but represents the effect of the City of Olympia's diversions from the system. The addition of the actual Olympia diversion records to the gaged records would provide a more realistic picture of the natural flow from McAllister Springs. Given that the unadjusted flow was compared to the maximum depletions based on annual volume limits, the flow is sufficient in all but three months. Groundwater recharge is not factored into these estimates. Groundwater availability may offset some of the apparent shortages.

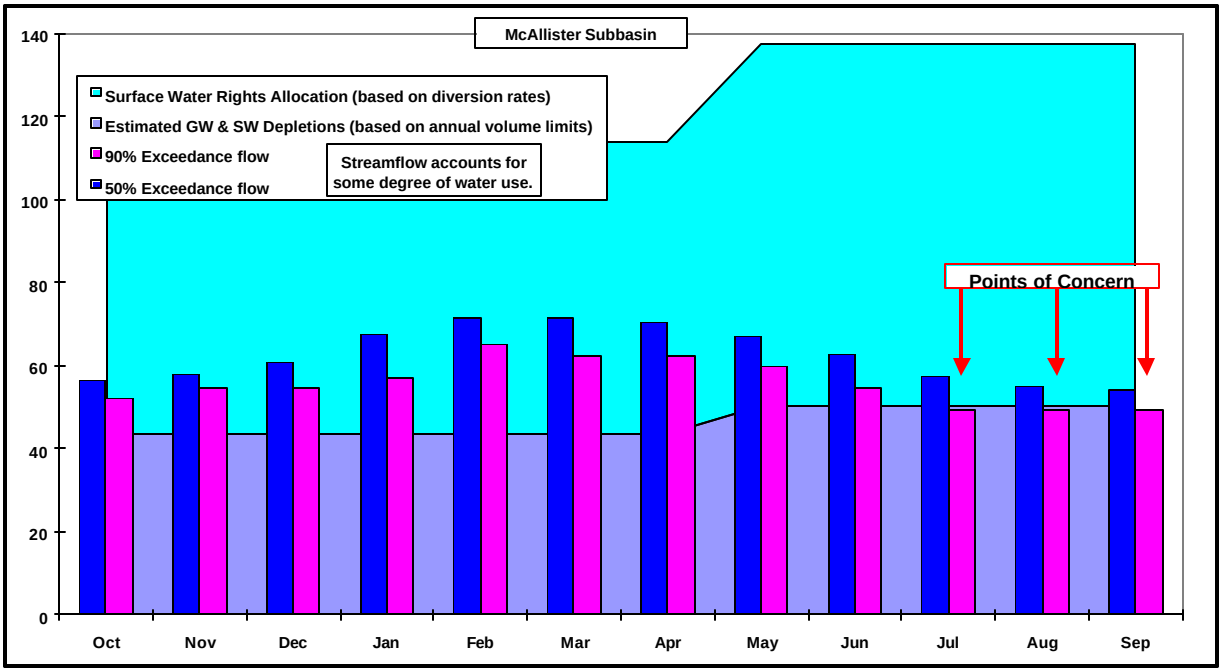


Figure 5.3-18: McAllister Subbasin – Depleted Streamflow vs. Water Allocation & Estimated Depletions from Surface Water Rights

MUCK/MURRAY

Water Rights

There were 70 surface water certificates and permits for a total diversion rate of 21.65 cfs and 217 ground water rights for a total withdrawal rate of 24,351 gpm (54.2 cfs). An additional 0.7 cfs (one surface water) and 5,431 gpm (12.1 cfs) (30 ground water) are associated with applications on file (Table 5.3-19).

The largest right in the Muck/Murray Subbasin was a ground water right for the City of Dupont in the amount of 2,200 gpm (4.9 cfs) and an annual volume limit of 774 acre-feet. Most of the city (90%) is out of the basin and as a result most of the water diverted under this right is a 100% depletion to the subbasin resources. Because of its location far from Muck or Murray Creeks, however, the water right was excluded from the depletion analysis (Table 5.3-23). The next largest right (4.0 cfs) is a non-consumptive right for fisheries production. The 3rd and 4th largest rights are mostly non-consumptive; both have rates of 2.22 cfs, one is for frost protection (2 acre-feet/year limit) and one is for recreation/beautification (70 acre-feet/year limit). The remaining rights are all less than 2.0 cfs, both surface and ground.

For surface water, 35% of the rights cover 90% of the allocated water while 59% of the ground water rights covers 90% of those allocations. To analyze 80% of the allocated water, 22% of the surface water and 37% of the ground water rights need to be investigated in detail (Figure 5.3-20).

Multiple domestic rights and irrigation rights account for most of the annual allocated volume of ground water. Surface water allocations by volume are about 15% (excluding applications) of the ground water volumes, therefore, this subbasin would warrant further investigation of the ground water resources and the issues of hydraulic continuity with Muck Creek and the mainstem Nisqually River.

There were 2,696 acres tabulated under certificates and permits, 38% of the acres are documented as irrigated under surface water rights.

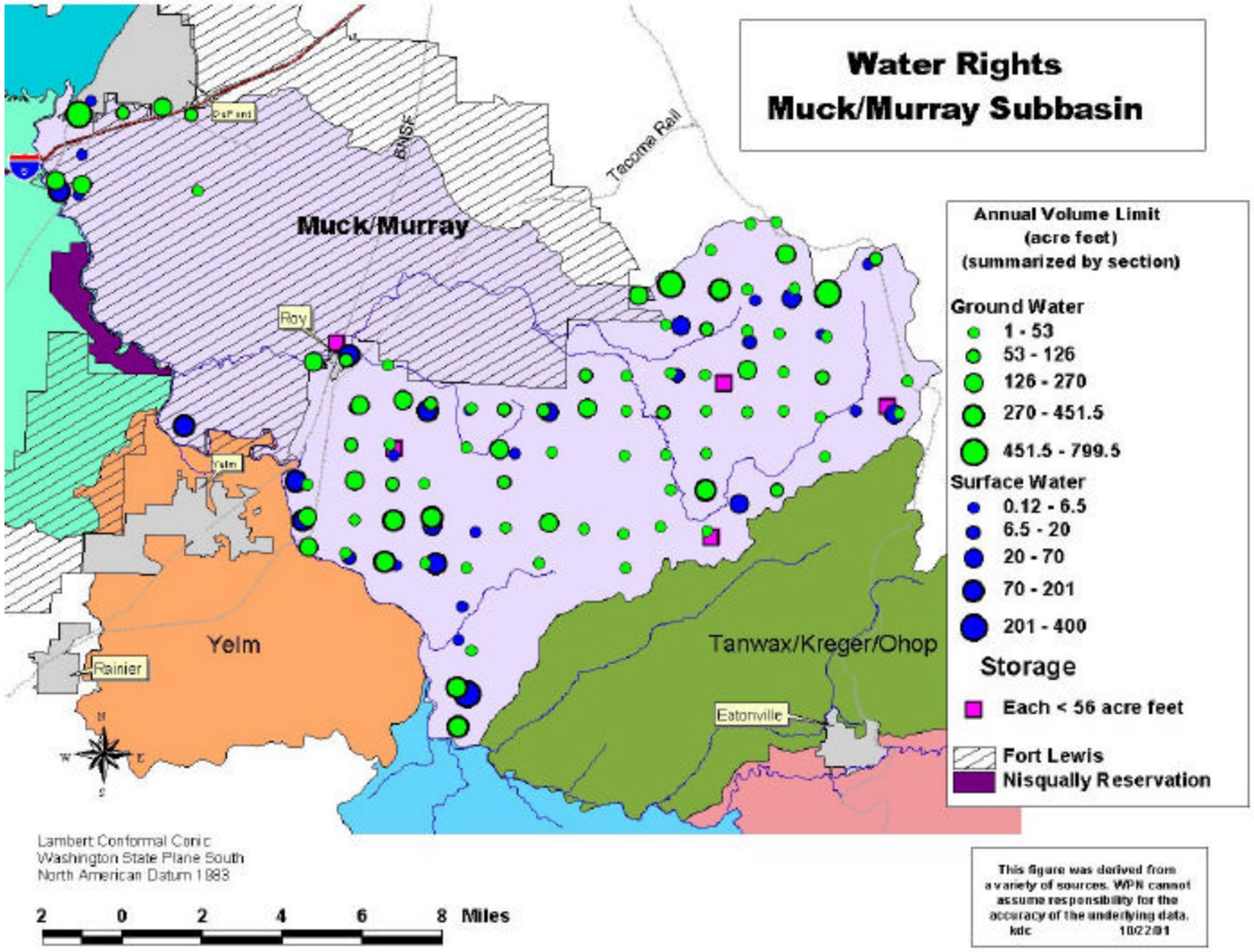


Figure 5.3-19: Muck/Murray Subbasin – Water Rights Summary by Volume (acre-feet)

Table 5.3-20: Muck/Murray Subbasin - Summary of Water Rights Certificates, Permits, and Applications

Primary Beneficial Use	All Certificates					Ground Water Certificates				Surface Water Certificates				Storage Certificates	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
	# rights	*cfs*	*gpm*	*af*	*acres*	*# rights*	*gpm*	*af*	*acres*	*# rights*	*cfs*	*af*	*acres*	*# rights*	*af*
Commercial/Industrial	1		25	2		1	25	2							
Multiple Domestic	105	0.21	6,678	2,719		102	6,678	2,642		3	0.21	77			
Single Domestic	25	0.20	278	225		12	278	213		13	0.20	12			
Environ. Quality	1		35	13		1	35	13							
Fire Protection	6	2.24	260	199		4	260	196		2	2.24	3			
Fish Propagation	9	5.47	50	94		1	50	81		7	5.47	6		1	8
Irrigation	76	8.29	7,120	3,886	2,042	47	7,120	2,512	1,322	29	8.29	1,375	720		
Municipal	6	0.00	1,560	1,021		6	1,560	1,021							
Recreation	9	3.49	100	221		1	100	19		5	3.49	70		3	132
Right of Way	2		150	122		2	150	122							
Stock	28	0.73	3,877	1,802	626	20	3,877	1,787	625	8	0.73	15	1	0	0
Wildlife	4	0.61	90	78	28	1	90	53	20	2	0.61	17	8	1	8
Totals:	**272**	**21.24**	**20,223**	**10,379**	**2,696**	**198**	**20,223**	**8,659**	**1,967**	**69**	**21.24**	**1,574**	**729**	**5**	**147**

Primary Beneficial Use	All Permits					Ground Water Permits				Surface Water Permits				Storage Permits	
		Flow Rates		Volume	Irrigated		Flow Rate	Volume	Irrigated		Flow Rate	Volume	Irrigated		Volume
	# rights	*cfs*	*gpm*	*af*	*acres*	*# rights*	*gpm*	*af*	*acres*	*# rights*	*cfs*	*af*	*acres*	*# rights*	*af*
Multiple Domestic	17	0.00	1,908	793		17	1,908	793							
Single Domestic	1	0.02		1						1	0.02	1			
Fish Propagation	1		20	4		1	20	4							
Municipal	1		2,200	774		1	2,200	774							
Totals:	**20**	**0.02**	**4,128**	**1,572**	**0**	**19**	**4,128**	**1,571**	**0**	**1**	**0.02**	**1**	**0**	**0**	**0**

Primary Beneficial Use	All Applications					Ground Water Applications				Surface Water Applications				Storage Applications	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
	# rights	*cfs*	*gpm*	*af*	*acres*	*# rights*	*gpm*	*af*	*acres*	*# rights*	*cfs*	*af*	*acres*	*# rights*	*af*
Multiple Domestic	18		3,457			18	3,457								
Single Domestic	1		19			1	19								
Frost Protection	1		225			1	225								
Irrigation	8	0.70	540		168	7	540		145	1	0.70		23		
Municipal	2		990			2	990								
Stock	1		200			1	200								
Totals:	**31**	**0.70**	**5,431**	**0**	**168**	**30**	**5,431**	**0**	**145**	**1**	**0.70**	**0**	**23**	**0**	**0**

TOTAL:	**323**	**21.95**	**29,782**	**11,951**	**2,864**	**247**	**29,782**	**10,230**	**2,112**	**71**	**21.95**	**1,574**	**752**	**5**	**147**

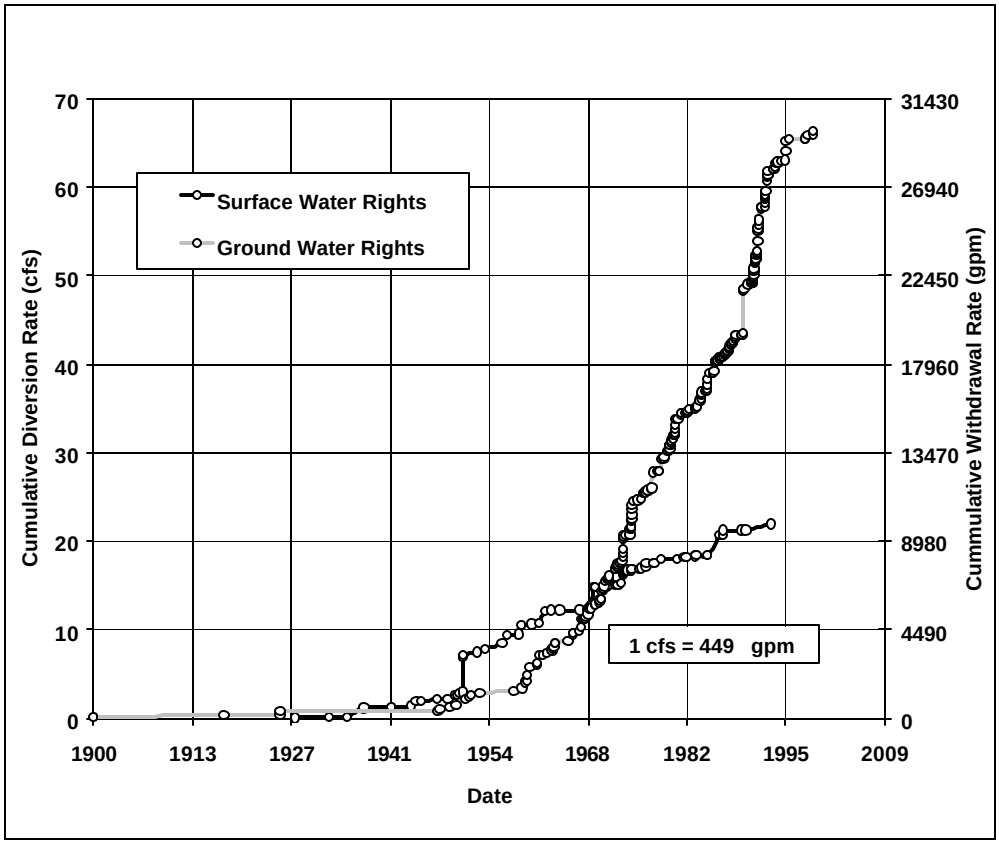


Figure 5.3-20: Muck/Murray Subbasin – Water Allocated Over Time

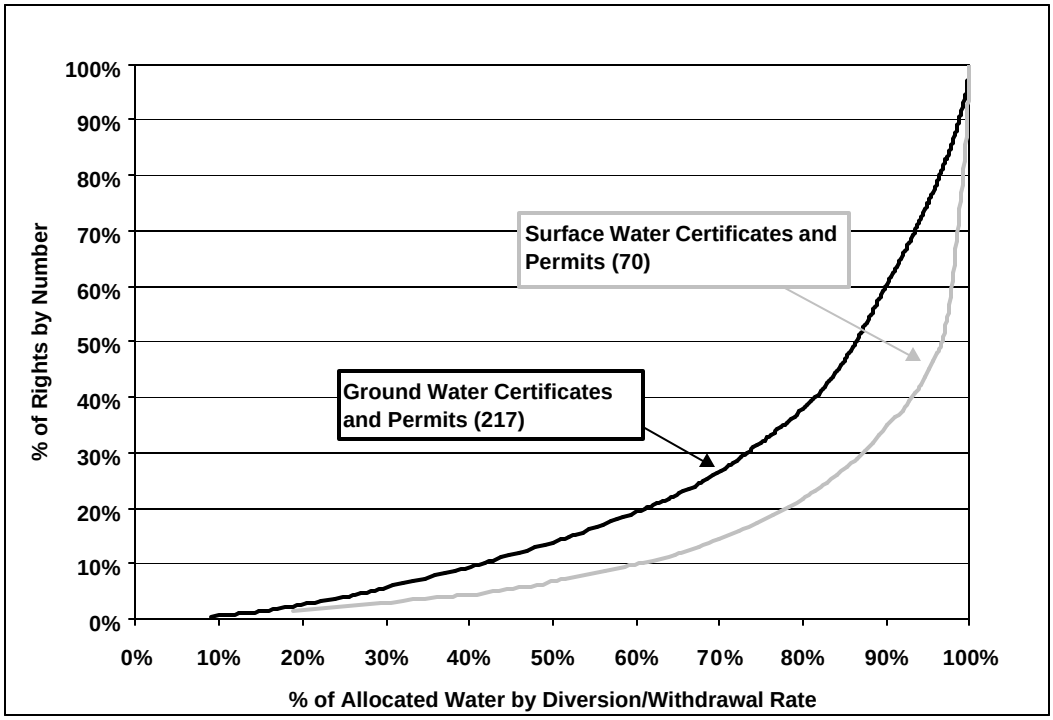


Figure 5.3-21: Muck/Murray Subbasin - Percent of Rights Covering Percent Allocated Water

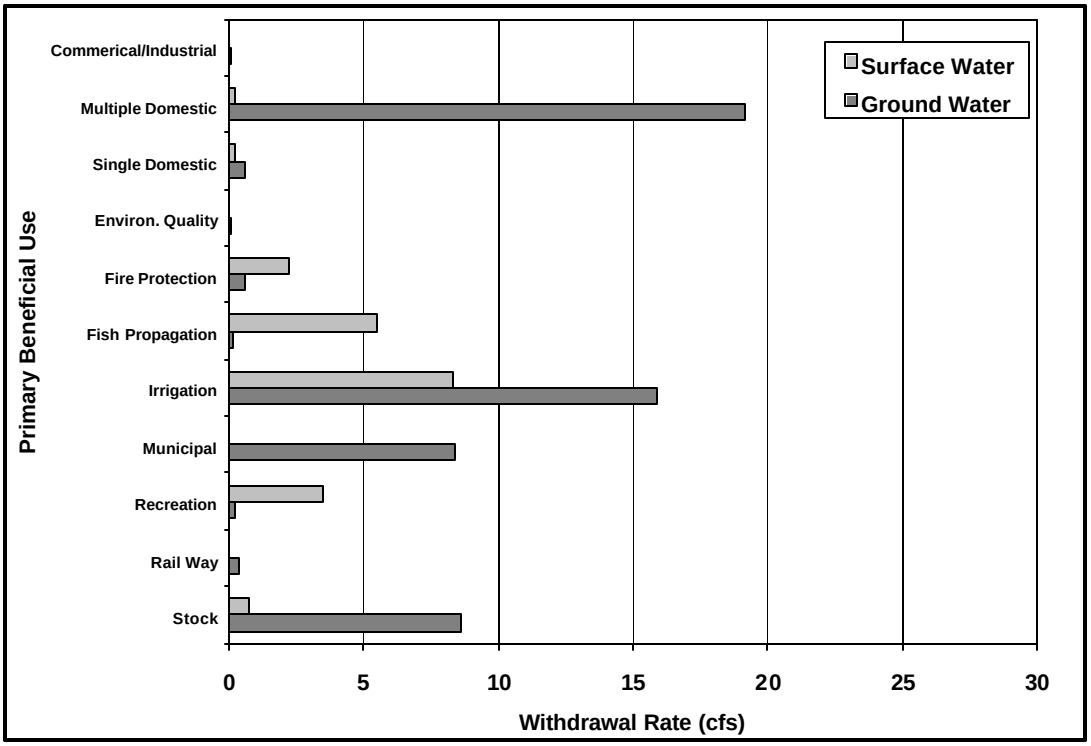


Figure 5.3-22: Muck/Murray Subbasin - Allocated Diversion/Withdrawal Rate by Primary Beneficial Use (cfs)

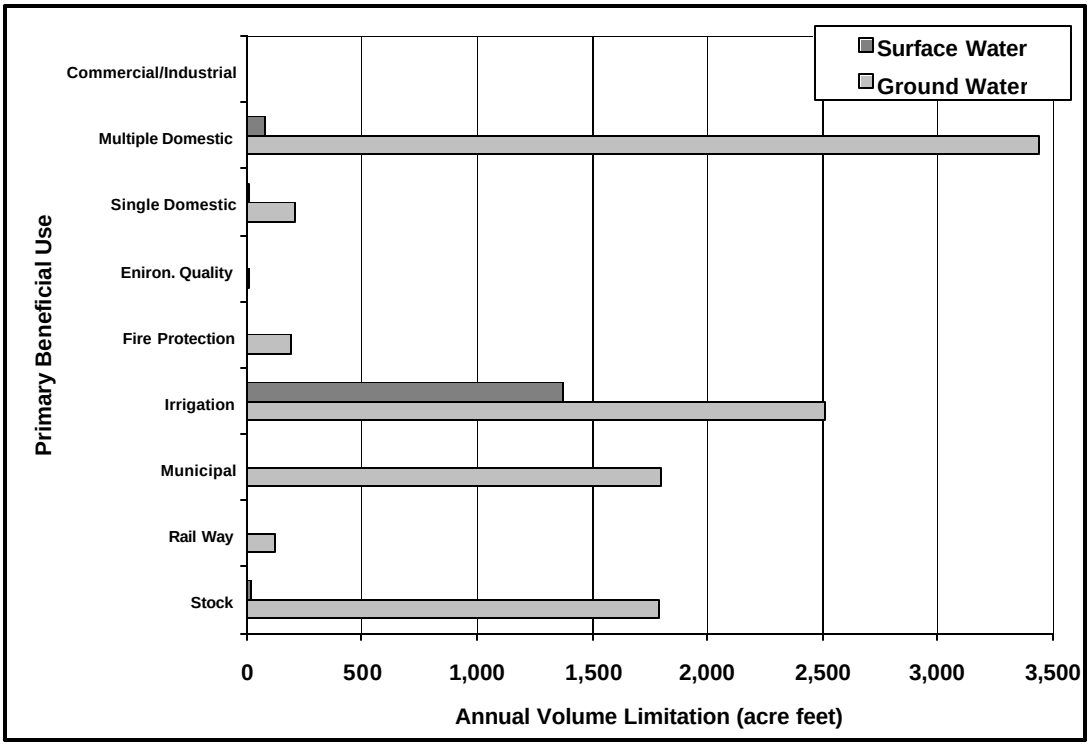


Figure 5.3-23: Muck/Murray Subbasin - Allocated Volume Limits by Primary Beneficial Use (acre-feet)

Water Use

While the Ft. Lewis federal reservation encompasses a large portion of the Muck Creek Subbasin, there is no permanent residential population within the subbasin. In addition, the primary water supply for the reservation is located outside of WRIA 11. Therefore, there is no significant water use associated with this land use in the Muck Creek Subbasin (Brown, 2001).

Residential Water Use

The population in the Muck/Murray Subbasin was 27,454, as estimated from the 2000 census. Based on the estimated average day demand of 153 gcd and the maximum day demand of 306 gcd, the winter season residential demand for this subbasin was approximately 6.5 cfs and the summer season demand was 13 cfs. The net depletion from winter water demand was estimated at 0.84 cfs. The net depletion to the surface/ground water system from the summer season demand was estimated at 3.64 cfs .

Public Water Systems

The Muck subbasin is the source of water supply for 344 public water systems. Of these, there are 53 Group A - Public Water Systems that serve a total population of 16,760 with 6,532 residential connections. In addition, there are 121 non-residential connections, resulting in a total of 6,653 connections. The largest five Group A systems represent 73% of the population and 72% of the residential connections served by this classification of public water systems (Table 5.3-21).

The DuPont Water System is primarily situated out-of-basin even though the source of the water supply is within the Muck/Murray Subbasin. The water withdrawal from the Muck/Murray Subbasin would constitute an out-of-basin diversion with 100% depletion.

There are 291 Group B Public Water Systems serving 3,595 people; 1,355 residential connections and 59 non-residential connections. The largest of the Group B systems serves 24 people with 9 residential connections.

Table 5.3-21: Muck Subbasin – Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections	Computed Number of People/Household
Southwood Water System	8,339	3,335	0	3,335	2.50
Indian Springs Water Company	1,265	506	0	506	2.50
Graham Hill Mutual Water Co Inc	1,148	287	0	287	4.00
DuPont Water System	820	368	6	374	2.23
McKenna Water District	588	184	0	184	3.20
Total	**12,160**	**4,680**	**6**	**4,686**	

Source: Washington Department of Health, 2001

Exempt Wells

With a total population of 27,454 and a PWS population of 20,355, those self-supplied water users under an exempt well or a non-PWS single or multiple domestic right total about 7,099 people. Subtracting out the 65 people using water under 26 single domestic rights results in 7,034 people self-supplied under multiple domestic rights or exempt wells. Further investigation of the multiple domestic rights, of which there were 122, would provide the detail needed to understand more accurately the number of homes on exempt wells.

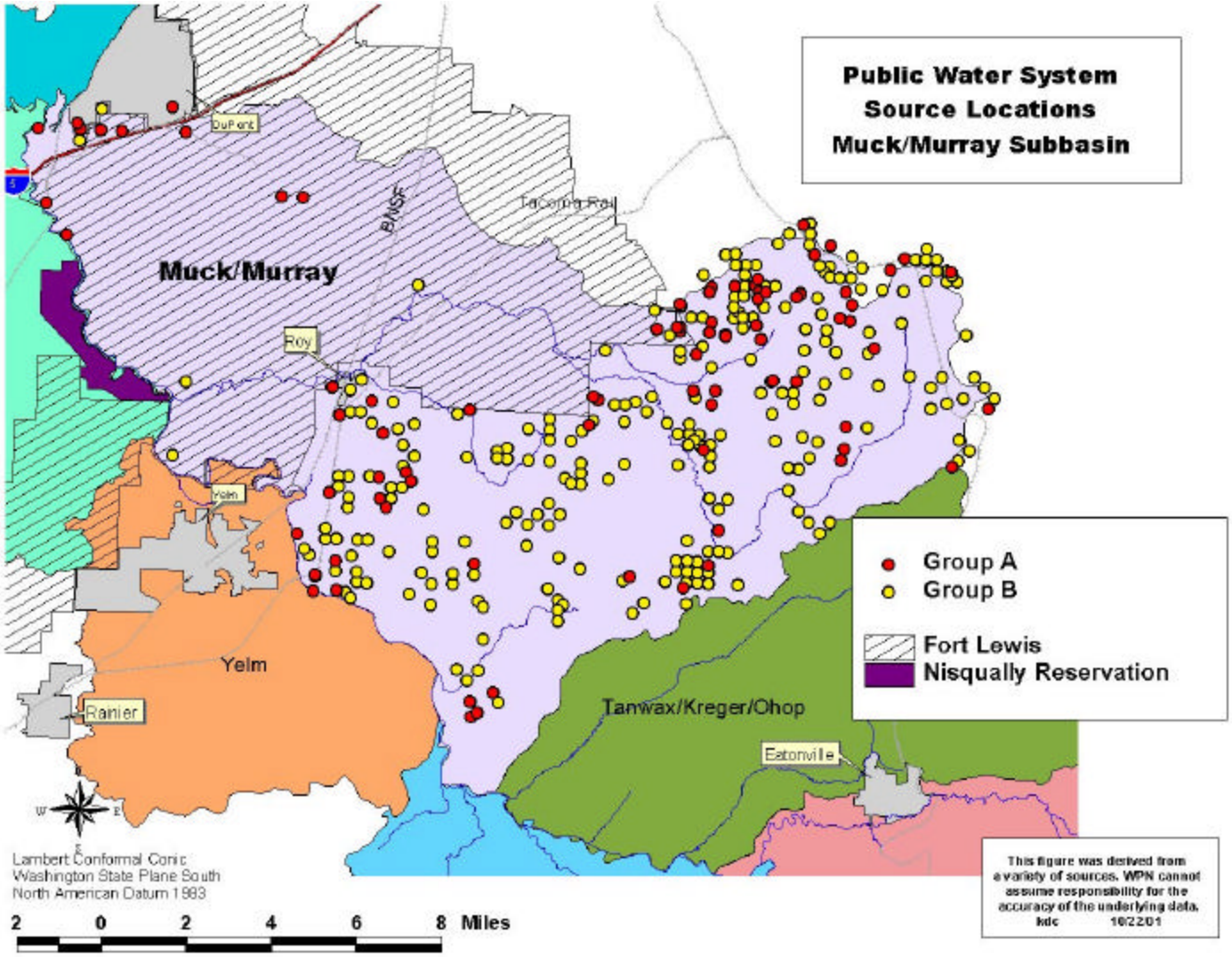


Figure 5.3-24: Muck/Murray Subbasin - Public Water System Source Locations

Comparison of Streamflow and Allocated Water

Comparison of the streamflow and allocated water both (as diversion/withdrawal rates as well as depletions based on annual volume limits) show concern for overallocation in the summer months (Figure 5.3-24). Allocated water exceeds or very nearly exceeds streamflows at both the 50% and 90% values from July through October. At the 90% exceedance level, estimated depletions are near the streamflows for June and November also. The overallocation in this basin is in part due to the low to nonexistent summer flows primarily at the 90% exceedance level. This may be a natural phenomenon, however the streamflows used in this level 1 analysis were not adjusted to account for upstream diversions. Investigation into an estimate of undepleted streamflows may be warranted for this basin. The comparison of streamflow to water allocation and associated depletions (estimated) overstates the points of concern since ground water was included in this calculation. This leads to the need to understand the extent of surface water capture from ground water pumping.

Table 5.3-22: Muck/Murray Subbasin - Water Right Depletions Based on Annual Volume Limits (excludes storage losses)

Use Sector	Annual Limits (Acre-feet)	Depletion Winter (Acre-feet)	Depletion Winter (cfs)	Depletion Summer (Acre-feet)	Depletion Summer (cfs)
Commercial	2	0.5	0.001	1.0	0.003
Multiple domestic	3512	151	0.36	590	1.94
Single Domestic	226	10	0.02	38	0.13
Irrigation	5194	0	0.00	2233	7.36
Municipal – (in-of-basin)	481	21	0.05	81	0.27
Municipal - (out-of-basin)	540	23	0.06	91	0.30
Stock 87% depletion	550	278	0.66	201	0.66
Other (non-consumptive)	672	0	0.00	0	0.00
Total	**11,177**	**482**	**1.15**	**3233**	**10.65**
Municipal – (DuPont not included in total)	774	450	1.07	324	1.07
Solly et.al., 1993 Winter = October through April, Summer = May through September					

Note: The values calculated in Table 5.3-22 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be reported as zero. Also keep in mind that in the case where more than one use was

identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

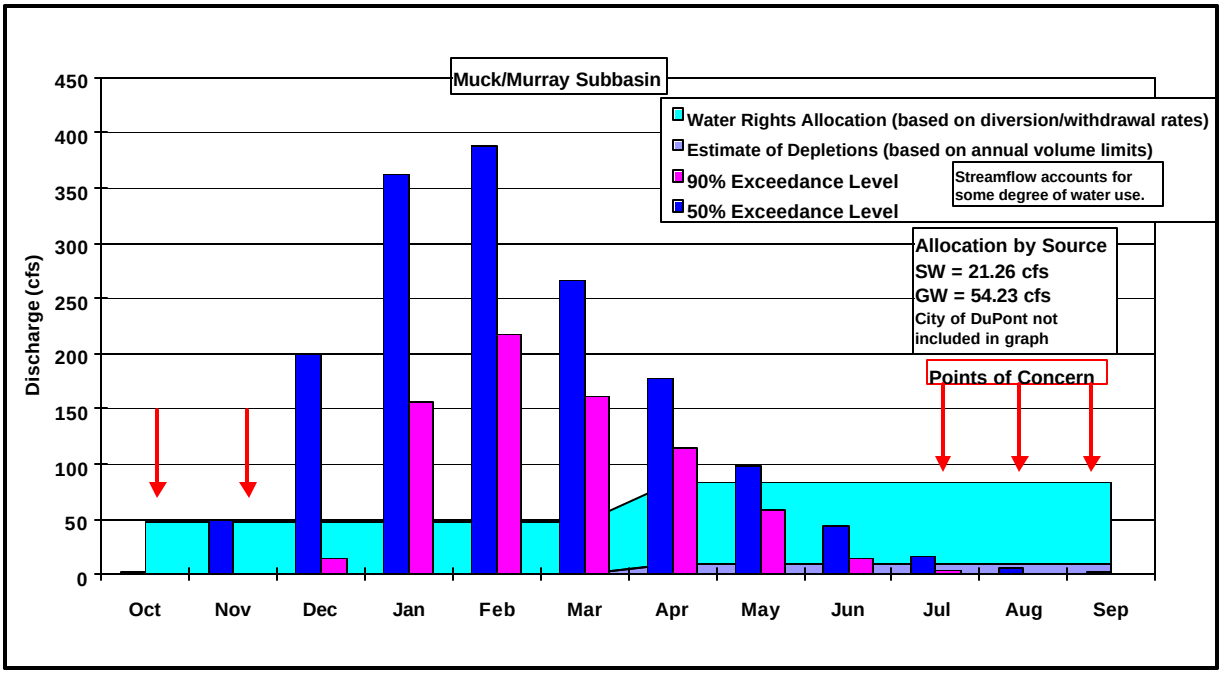


Figure 5.3-25 : Muck/Murray Subbasin – Streamflow vs. Water Allocation & Estimated Depletions to Water Rights (City of DuPont right has been excluded from the graph)

YELM

Water Rights

There were a total of 180 water rights in the Yelm subbasin of which 93% were certificates (Table 5.3-23). Nine applications were pending and two changes associated with two separate rights were also pending; four permits were on file and have not been "perfected" (demonstrated beneficial use). By volume, the largest allocation of water was for hydropower purposes followed by irrigation and then multiple domestic water use. The Town of Centralia holds the two power rights, a 1927 right for 720 cfs and a 1989 right for 80 cfs. The annual volume limitation of the latter right is 58,000 af, an amount of water substantially higher than any other use in this subbasin; these are non-consumptive rights except within the bypass reach. The Centralia Power Canal diverts water from the Nisqually River and runs it through a power generation facility at the tail

end of the canal after which it returns to the Nisqually River. The City of Centralia also holds a fish production right for 3.0 cfs, also non-consumptive.

The City of Yelm currently has three water rights certificates with an annual volume limitation of 613 acre-feet and a combined instantaneous ground water withdrawal rate of 1,700 gpm. A pending change (CG2-22969) from a certificate appears to be a transfer from stock, irrigation, domestic to municipal for an additional 84.4 acre-feet. This brings the total volume to 697.4 acre-feet. The actual acre-feet of water available to Yelm, per WDOE, is 564 acre-feet. Yelm's records indicate 676 acre-feet. The difference has yet been reconciled with the DOE (City of Yelm, 2001). An additional four water right applications are on file for 8,500 gpm and pending; one of these is for the irrigation of 500 acres. Annual volume limitations are not assigned to applications. The acres designated for irrigation associated with water rights totals 2,677. Ground water is the designated source for nearly 80% of these potentially irrigated acres. Irrigation represents the largest use of water in the Yelm subbasin after the hydropower rights.

Ground water appeared to be the predominant source of water supply, outside of the large hydropower rights, in the Yelm Subbasin. Figure 5.3-26 illustrates the cumulative rates of both surface and ground water for all certificates, permits, and applications. The total allocation of water via ground water rights including applications was 29,855 gpm (66.49 cfs). The total allocation via surface water rights was 9.45 cfs plus the 800 cfs power right. Further investigation of ground water and hydraulic continuity is warranted in this subbasin to determine the net effect of ground water pumping on the surface water source.

Of the surface water certificates and permits, 11 (38%) account for 90% of the allocated surface water based on the diversion rate. In contrast, 79 of the 136 (58%) ground water rights cover 90% of the allocated ground water withdrawals. The surface and ground water rights that account for 80% of the diversions/withdrawals were 24% and 42%, respectively (Figure 5.3-27).

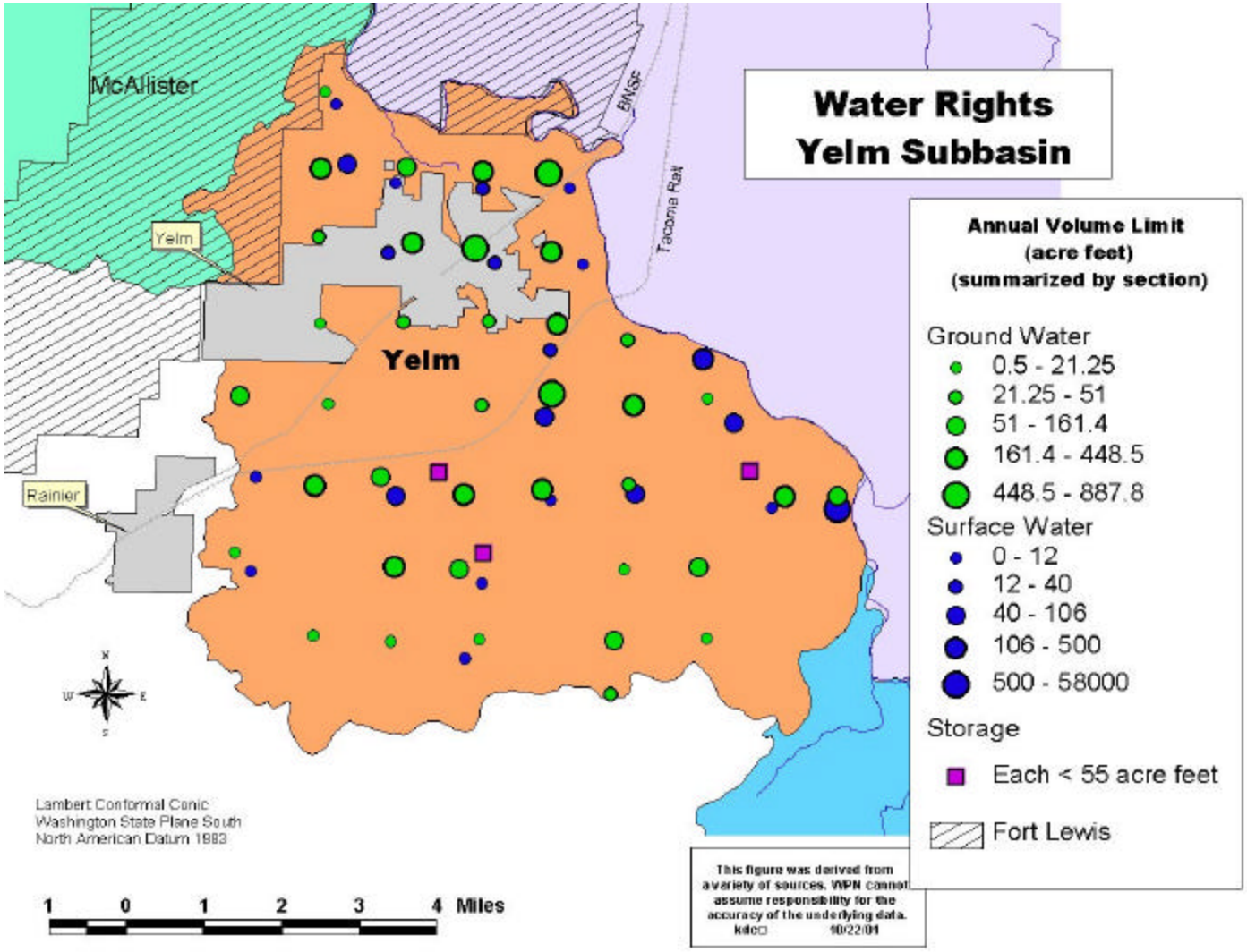


Figure 5.3-26: Yelm Subbasin – Water Rights Summary by Volume (acre-feet)

Table 5.3-23: Yelm Subbasin – Water Rights Summary of Certificates, Permits, and Applications

Primary Beneficial Use	All Certificates # rights	Instantaneous Flow Rates cfs	Instantaneous Flow Rates gpm	Annual Volume Limit af	Potentially Irrigated acres	Ground Water Certificates # rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	Surface Water Certificates # rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	Storage Certificates # rights	Storage Certificates Annual Volume Limit af
Multiple Domestic	39	0.02	3,618	1,064		38	3,618	1,063		1	0.02	1			
Single Domestic	10	0.08	80	10		4	80	4		6	0.08	6			
Fire Protection	1		20	4		1	20	4							
Fish Propagation	3	3.22		1						3	3.22	1			
Irrigation	79	4.52	9,903	3,749	1,926	61	9,903	2,906	1,527	17	4.52	789	400	1	54
Municipal	3		1,700	613		3	1,700	613							
Power	2	800.00		58,000						2	800.00	58,000			
Recreation	2		250	39		2	250	39							
Stock	27	1.61	4,263	2,038	751	24	4,263	1,720	593	3	1.61	318	158		
Wildlife	1			7										1	7
Totals:	**167**	**809.45**	**19,834**	**65,525**	**2,677**	**133**	**19,834**	**6,349**	**2,120**	**32**	**809.45**	**59,115**	**558**	**2**	**61**

Primary Beneficial Use	All Permits # rights	Instantaneous Flow Rates cfs	Instantaneous Flow Rates gpm	Annual Volume Limit af	Potentially Irrigated acres	Ground Water Permits # rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	Surface Water Permits # rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	Storage Permits # rights	Storage Permits Annual Volume Limit af
Multiple Domestic	2		112	16		2	112	16							
Recreation	2		110	140	40	1	110	140	40					1	no data
Totals:	**4**	**0.00**	**222**	**156**	**40**	**3**	**222**	**156**	**40**	**0**	**0.00**	**0**	**0**	**1**	**0**

Primary Beneficial Use	All Applications # rights	Instantaneous Flow Rates cfs	Instantaneous Flow Rates gpm	Annual Volume Limit af	Potentially Irrigated acres	Ground Water Applications # rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	Surface Water Applications # rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	Storage Applications # rights	Storage Applications Annual Volume Limit af
Multiple Domestic	2		150			2	150								
Irrigation	3		2,200		506	3	2,200		506						
Municipal	3		7,000			3	7,000								
Stock	1		450			1	450								
Totals:	**9**		**9,800**	**0**	**506**	**9**	**9,800**	**0**	**506**	**0**	**0.00**	**0**	**0**	**0**	**0**

TOTAL:	**180**	**809.45**	**29,855**	**65,681**	**3,223**	**145**	**29,855**	**6,505**	**2,666**	**32**	**809.45**	**59,115**	**558**	**3**	**61**

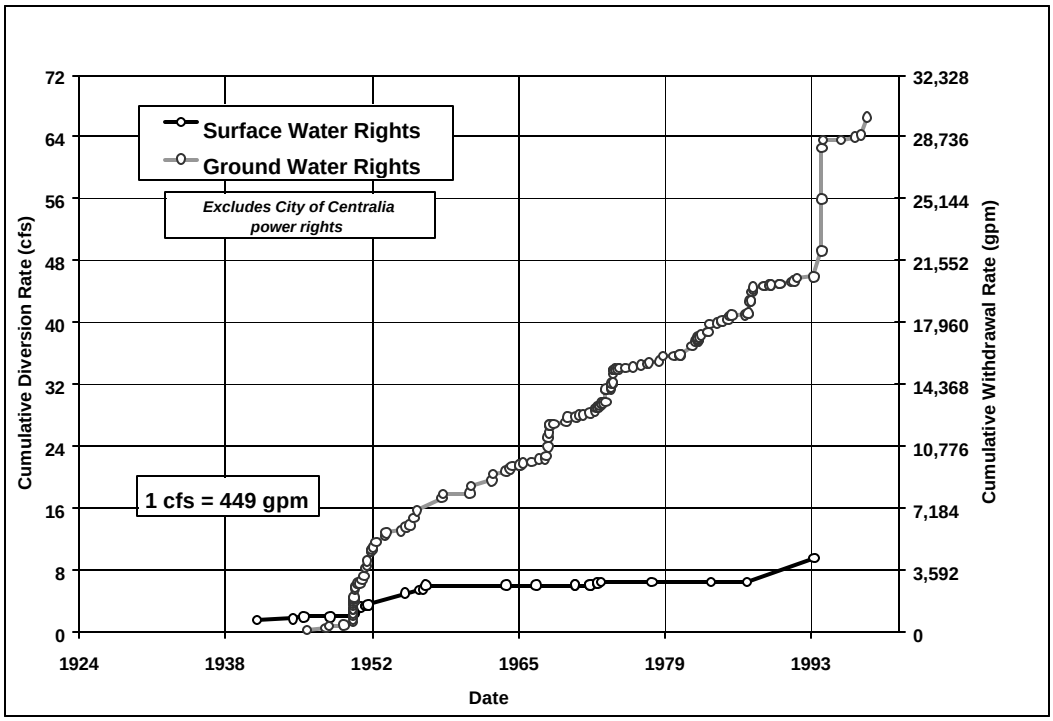


Figure 5.3-27: Yelm Subbasin – Water Allocated Over Time (excludes large hydropower rights)

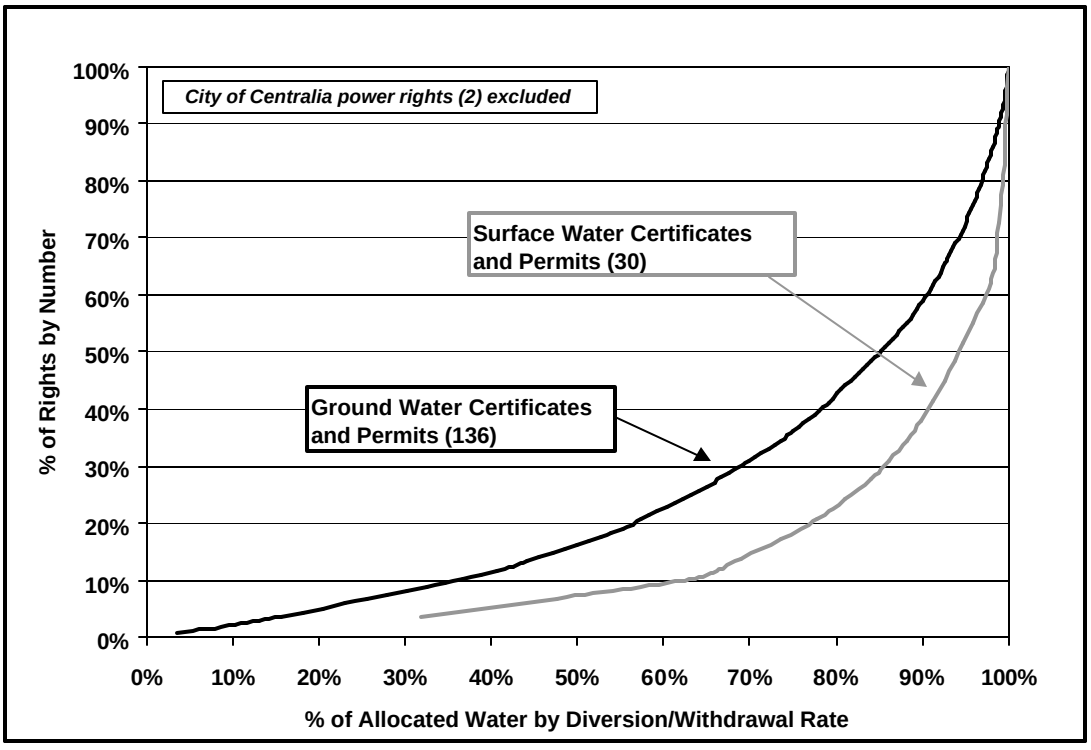


Figure 5.3-28: Yelm Subbasin – Percent of Rights Covering Percent Allocated Water

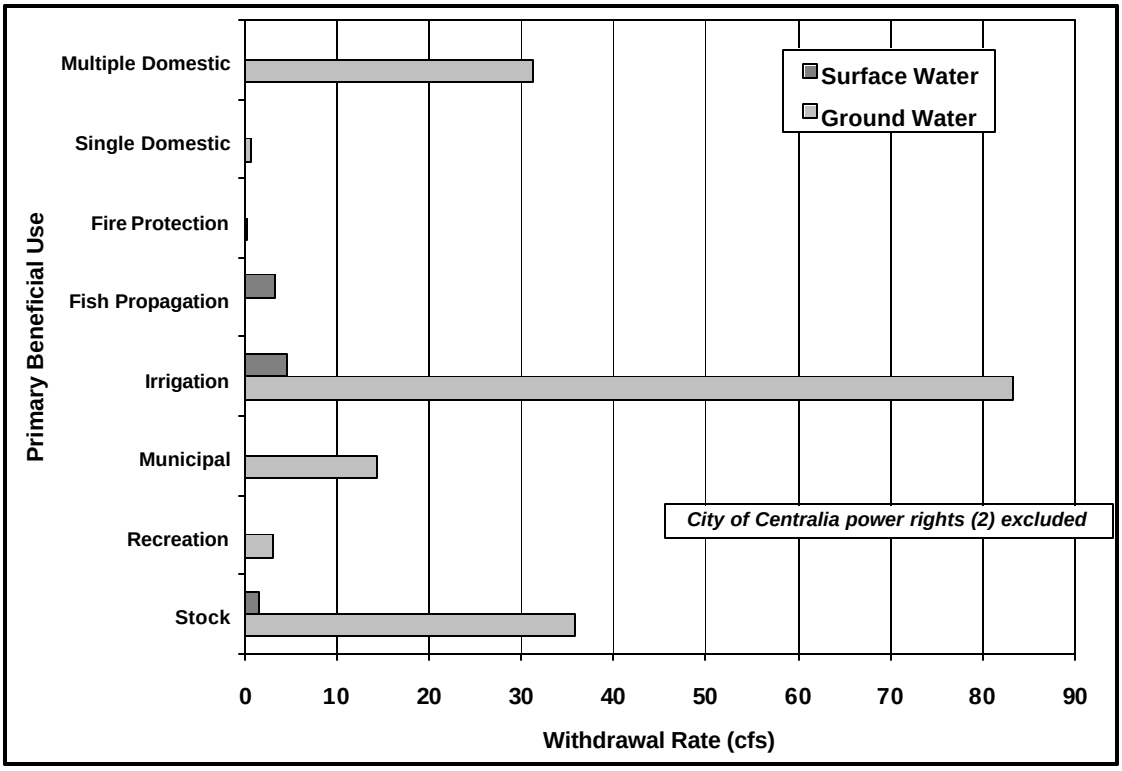


Figure 5.3-29: Yelm Subbasin – Allocated Diversion/Withdrawal Rate by Primary Beneficial Use (cfs)

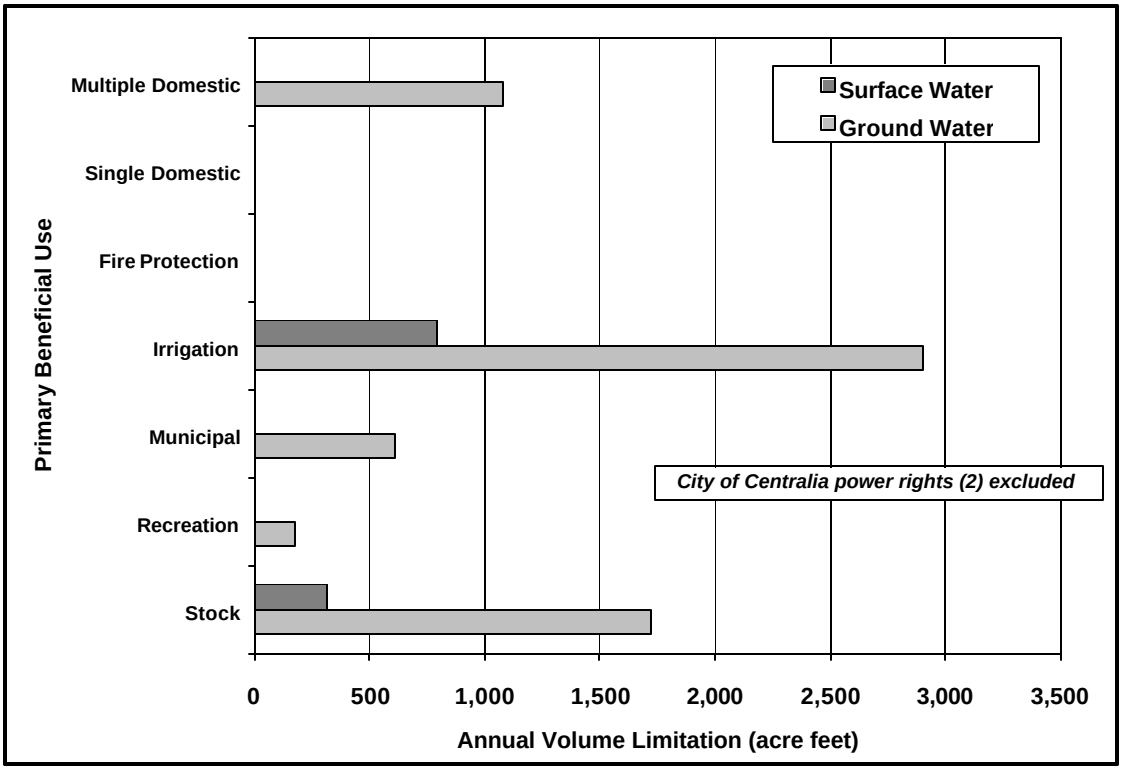


Figure 5.3-30: Yelm Subbasin – Allocated Volume Limits by Primary Beneficial Use (acre-feet)

Water Use

Residential Water Use

The 1990 population in the Yelm Subbasin was estimated at 7,396 while the 2000 population was projected at 9,511. This represents a projected population growth of 2.9%. According to recently released data by the United States Census Bureau, the 2000 population residing in the Yelm Subbasin is 11,288 (Census 2000). The actual 2000 population is therefore greater than the projected growth from the 1990 Census statistics; the rate of growth was 5.3% rather than 2.9%

Actual water use is often difficult to estimate given that most services are not metered. In the Yelm Subbasin, one of the reports made available to understand water use within the subbasin, City of Yelm Water Reuse Project, 1995, indicated a 1995 population of 2,188 for the City of Yelm and a 2000 estimate of 4,944. Assuming the WDOH data was up-to-date at the time the data were obtained, the City population is well below this estimate by more than 2,000 people. The per capita water usage in the study was estimated at 155 gallons per day (Skillings-Connolly Inc., 1995).

The design demand equation published by WDOH determines the gallons per day per Equivalent Residential Unit (ERU); one ERU is equivalent to one single-family residence. The equation is based primarily on average annual rainfall. The water demand that can be applied to the Yelm subbasin (average annual rainfall of 45 inches) is estimated at 148 gallons per capita per day (gcd). The per capita demand calculated using the WDOH procedure (148 gcd) was sufficiently similar to the City of Yelm's reported demand (155 gcd) to use the former as representative of the Yelm Subbasin

The 2000 population estimate of 11,288 for the whole subbasin was used to calculate an approximate water demand. The demand ranged from 2.64 cfs in the winter to 5.27 cfs in the summer months. The resulting net depletions to the system were 0.34 cfs and 1.48 cfs.

Public Water Systems

The Yelm subbasin is the source of water supply for 76 public water systems serving 7,186 people. There are 23 Group **A** Public Water Systems that serve a total population of 6,516 with 2,553 residential connections. In addition, there are 111 non-residential

connections, resulting in a total of 2,664 connections. The largest five Group A systems represent 92% of the population and 90% of the residential connections served by this classification of public water system (Table 5.3-25).

Table 5.3-24: Yelm Subbasin – Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections
City of Yelm	2,850	1,250	0	1,250
Nisqually Pines Community Club	2,000	636	96[1]	732
Lake Lawrence	699	233	0	233
Andrews First	280	112	0	112
Wildaire Estates	140	55	0	55
Total	**5,969**	**2,286**	**96**	**2,382**

Source: Washington Department of Health, 2001
1/ WDOH shows 96 non-residential connections, the City of Yelm has 170 on their records

There are 53 Group B Public Water Systems serving 670 people including 246 residential connections and 9 non-residential connections. The largest of the Group B systems serves 24 people on 10 residential connections. Two of the Group B systems have no information on population or connections.

The City of Yelm has developed a reclamation project to treat wastewater to a Class A standard[1]. The reclaimed water is used as ground water recharge, augmentation of surface water, and summer irrigation to offset the use of potable water. The source of supply for the City are wells that have been documented to be hydraulically connected to the springs that flow into Yelm Creek and subsequently into the Nisqually River. Currently, continuous recharge of the ground water is occurring in the amount of 50,000 gallons per day (56 acre-feet). The year-round surface water augmentation or return flow totals about 150,000 gallons per day (~118 acre-feet). During the summer, consumptive use of reclaimed irrigation water is roughly 50 acre-feet. As funding becomes available,

[1] Class A means high quality water with limited human interference. Discharges restricted to noncontact process water or highly treated wastewater of quality equal to or better than the receiving water. Impoundment permitted.

the City of Yelm intends to develop facilities such that the entire 118 acre-feet can be used as recharge to ground water. Surface water augmentation will be an option as part of this plan (Skillings, 2001).

Exempt Wells

The total subbasin population for 2000 was 11,288 of which 7,396 are supplied water by a public system. Out of the remaining 3,892 approximately 25 people are self-supplied under individual single domestic rights. The remaining population of 3,867 is self-supplied under a multiple domestic right (non-public water system) or an exempt well. Further investigation would be required to attain a better estimate of exempt well use.

Comparison of Streamflow and Allocated Water

The comparison of streamflow and allocated water is based on the water rights that have been awarded (certificates and permits). While the City of Yelm has a reuse program in place, WDOE has yet to provide them with credits for the reuse of their water supply. In that light, the comparison deals only with the water rights and not with the actual use or actual reuse of water. The annual volume limit used for the City of Yelm is the 676 acre-feet the City claims to have, which is different from the WRATS database and the amount which WDOE believes the City has.

Comparison of the streamflow to allocated water both (as diversion/withdrawal rates as well as depletions based on annual volume limits) show concern for overallocation in the summer months (Figure 5.3-31). Allocated water exceeds streamflows at both the 50% and 90% values from July through October. Comparisons of depletions to streamflows at the 90% exceedance level add June and November to the list of concern. The overallocation in this basin is in part due to the low to nonexistent summer flows primarily at the 90% exceedance level. This may be a natural phenomenon, however the streamflows used in this Level 1 analysis were not adjusted to account for upstream diversions. Investigation into an estimate of undepleted streamflows may be warranted for this basin.

The comparison of streamflow versus water allocation and associated depletions (estimated) overstates the points of concern since ground water was included in this calculation. This leads to the need to understand the extent of surface water capture from groundwater pumping.

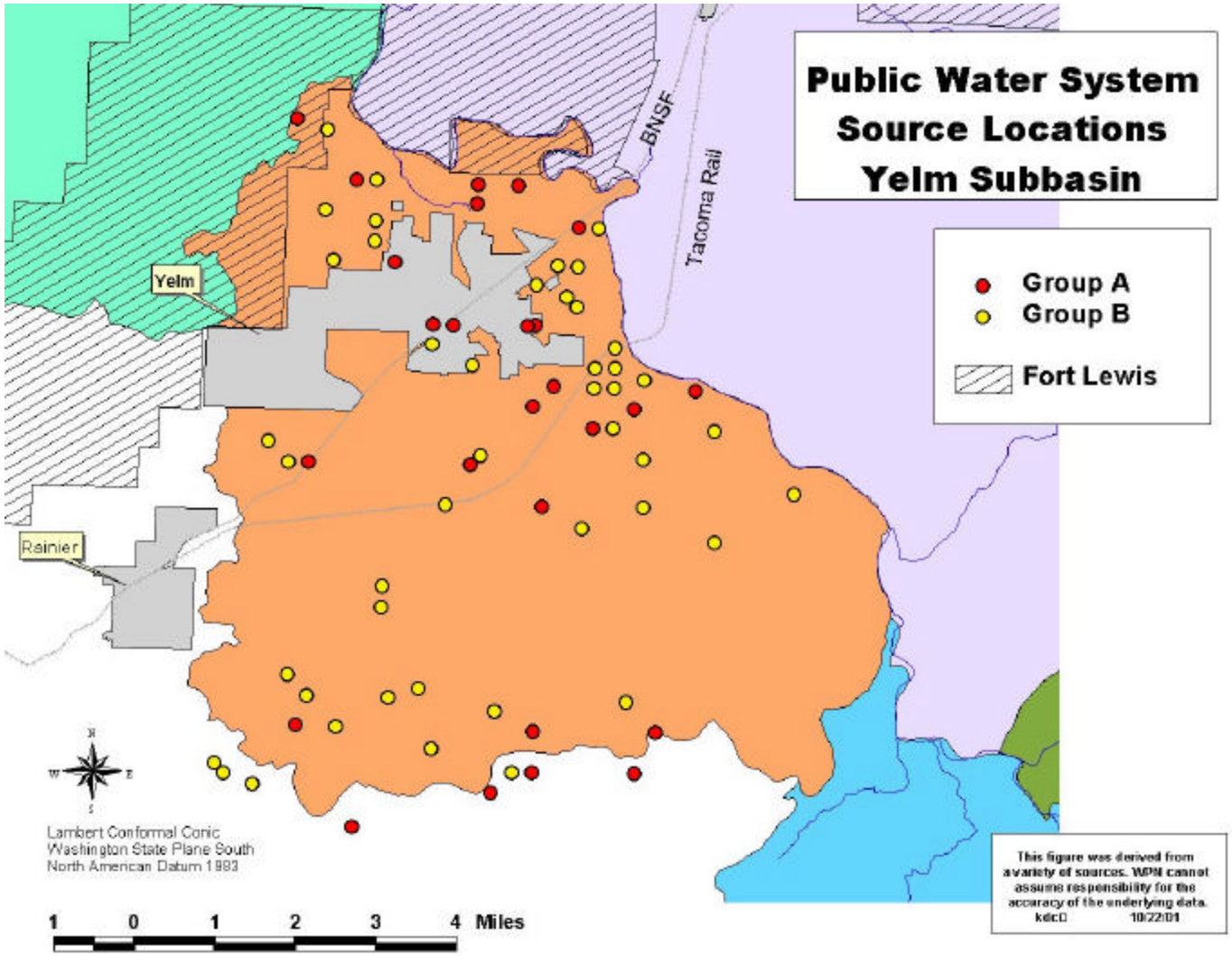


Figure 5.3-31: Yelm Subbasin – Public Water System Summary by Source Location

Table 5.3-25: Yelm Subbasin - Water Right Depletions Based on Annual Volume Limits (excludes Centralia power rights)

Use Sector	Annual Limits (acre-feet)	Depletion Winter (acre-feet)	Depletion Winter (cfs)	Depletion Summer (acre-feet)	Depletion Summer (cfs)
Multiple Domestic	1,080	46	0.11	203	0.67
Single Domestic	10	0	0.00	2	0.01
Irrigation	5,331	0	0.00	2292	7.55
Municipal* – (in-of-basin)	676	29	0.07	127	0.42
Stock 87% depletion	536	271	0.64	195	0.64
Other (non-consumptive)	111	0	0.00	0	0.00
Total	**7,744**	**347**	**0.82**	**2,819**	**9.29**

*All municipal rights are for the City of Yelm

[1]Solly et.al., 1993 Winter = October through April, Summer = May through September

Note: The values calculated in Table 5.3-25 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be reported as zero. Also keep in mind that in the case where more than one use was identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

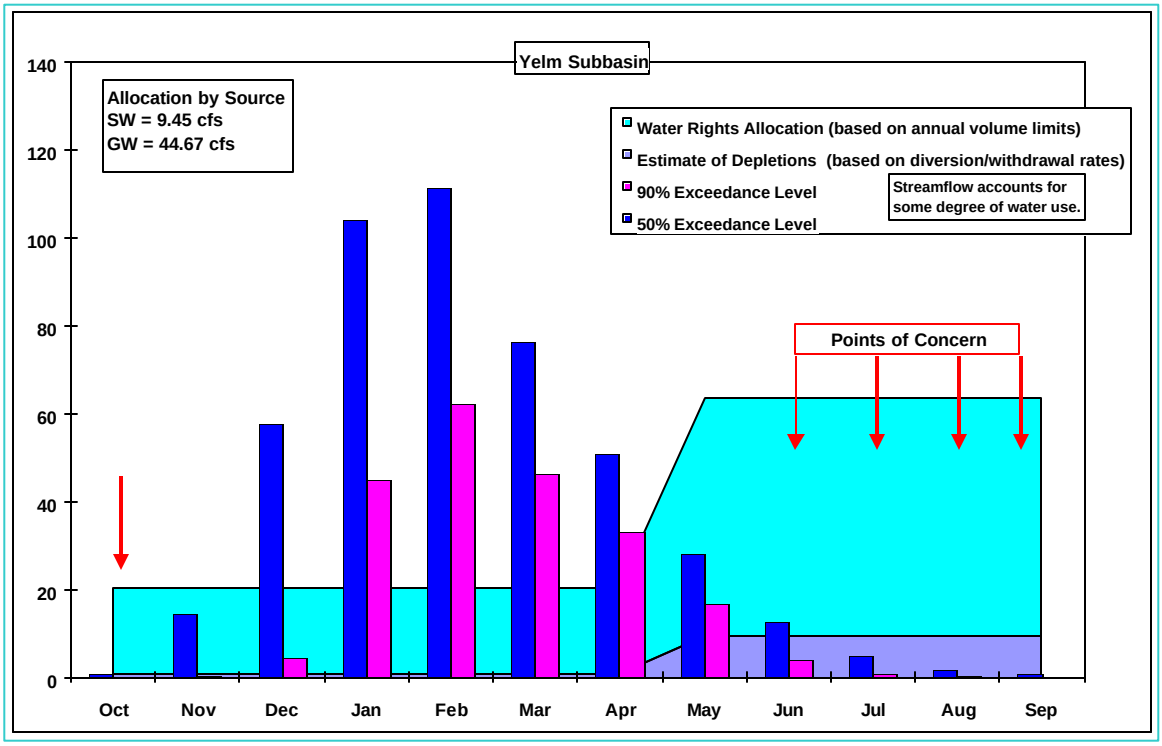


Figure 5.3-32: Yelm Subbasin – Streamflow vs. Water Allocation & Estimated Depletion to Water Rights

TOBOTON/POWELL/LACKAMUS

Water Rights

There were a total of 28 water rights in the Toboton/Powell/Lackamus Subbasin of which 75% were certificates (Table 5.3-26). Four ground water applications were pending and one change to a ground water right has been issued. Three permits were on file and have not demonstrated that they have been "perfected" (put to beneficial use) for the status to change from permit to certificate. The Clearwood Community Association holds the largest ground water certificate for 425 gpm and 529 acre-feet. Clearwood has also submitted an application for 1,000 gpm to serve 1,355 domestic units, the largest of the ground water applications.

The largest surface water right (1.20 cfs) is designated for wildlife, recreation, and fish production and is non-consumptive. The next largest right is for 0.5 cfs intended for wildlife, power, fisheries, irrigation of 2 acres, and a single domestic supply. The subsequent four rights are specified for irrigation of a combined 130 acres and a total diversion rate of 1.29 cfs. One of the older documents does not designate the annual volume limit therefore 2 acre-ft/acre was assumed and the total volume of the four rights

is 220 acre-feet/year. This is a common problem with the WDOE WRATS database. At this level of study, rights could not individually be researched and, therefore, the summaries are subject to errors; as stated the assumption of 2 acre-feet/acre was assigned to such irrigation rights.

Under certificates and permits, there were 197 acres covered for irrigation under 8 rights with irrigation as the primary beneficial use and 5 rights with irrigation listed as a secondary use; surface water is the source of supply for 9 of these. According to the Thurston County Conservation District (personal communication, 2001), there is little actual irrigation occurring in this subbasin.

Four of the eight ground water rights cover 95% of the cumulative withdrawal rate while roughly 60% (9 rights) of the surface water rights cover 95% of the diversion rate (Figure 5.3-34). The total combined withdrawal/diversion rate was 5.64 cfs of which 65% was attributed to surface water sources (Figure 5.3-35).

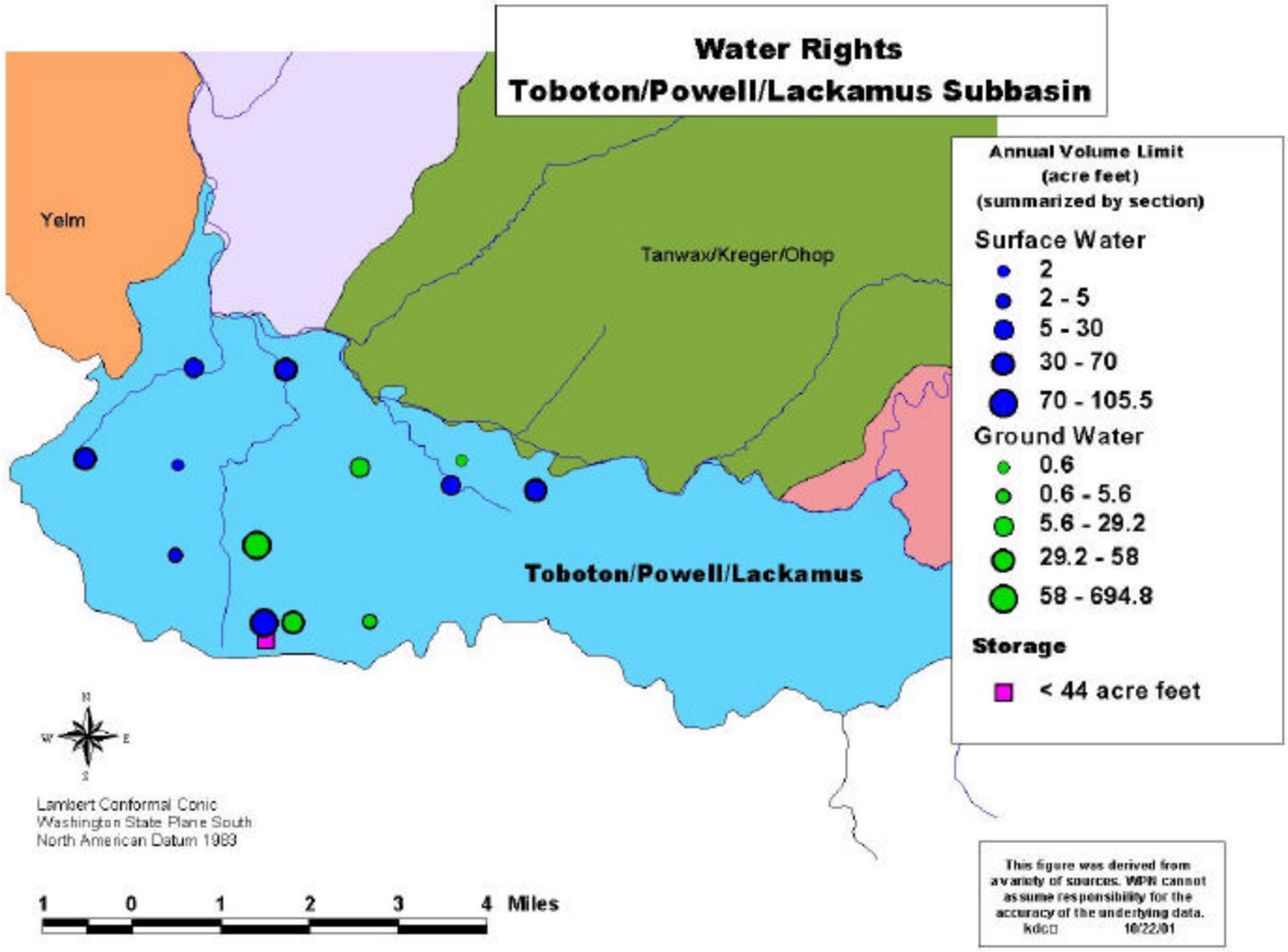


Figure 5.3-33: Toboton/Powell/Lackamus Subbasin – Water Rights Summary by Volume (acre-feet)

Table 5.3-26: Toboton/Powell/Lackamus Subbasin – Water Rights Summary of Certificates, Permits, and Applications

	All Certificates					Ground Water Certificates				Surface Water Certificates				Storage Certificates	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Multiple Domestic	8	0.10	740	769		7	740	765		1	0.10	5			
Single Domestic	2	0.02		3						2	0.02	3			
Irrigation	6	0.93	150	235	130	1	150	24	5	5	0.93	211	125		
Stock	2	0.35		100	50					2	0.35	100	50		
Wildlife	3	1.70		49	2					2	1.70	5	2	1	44
Totals	**21**	**3.10**	**890**	**1,156**	**182**	**8**	**890**	**788**	**5**	**12**	**3.10**	**324**	**177**	**1**	**44**

	All Permits					Ground Water Permits				Surface Water Permits				Storage Permits	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Single Domestic	1	0.02		1						1	0.02	1			
Irrigation	2	0.54		30	15					2	0.54	30	15		
Totals	**3**	**0.56**	**0**	**31**	**15**	**0**	**0**	**0**	**0**	**3**	**0.56**	**31**	**15**	**0**	**0**

	All Applications					Ground Water Applications				Surface Water Applications				Storage Applications	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Multiple Domestic	2		1,030			2	1,030								
Irrigation	1		30		3	1	30		3						
Stock	1		150		50	1	150		50						
Totals	**4**		**1,210**	**0**	**53**	**4**	**1,210**		**53**						

TOTAL:	**28**	**3.66**	**2,100**	**1,186**	**250**	**12**	**2,100**	**788**	**58**	**15**	**3.66**	**354**	**192**	**1**	**44**

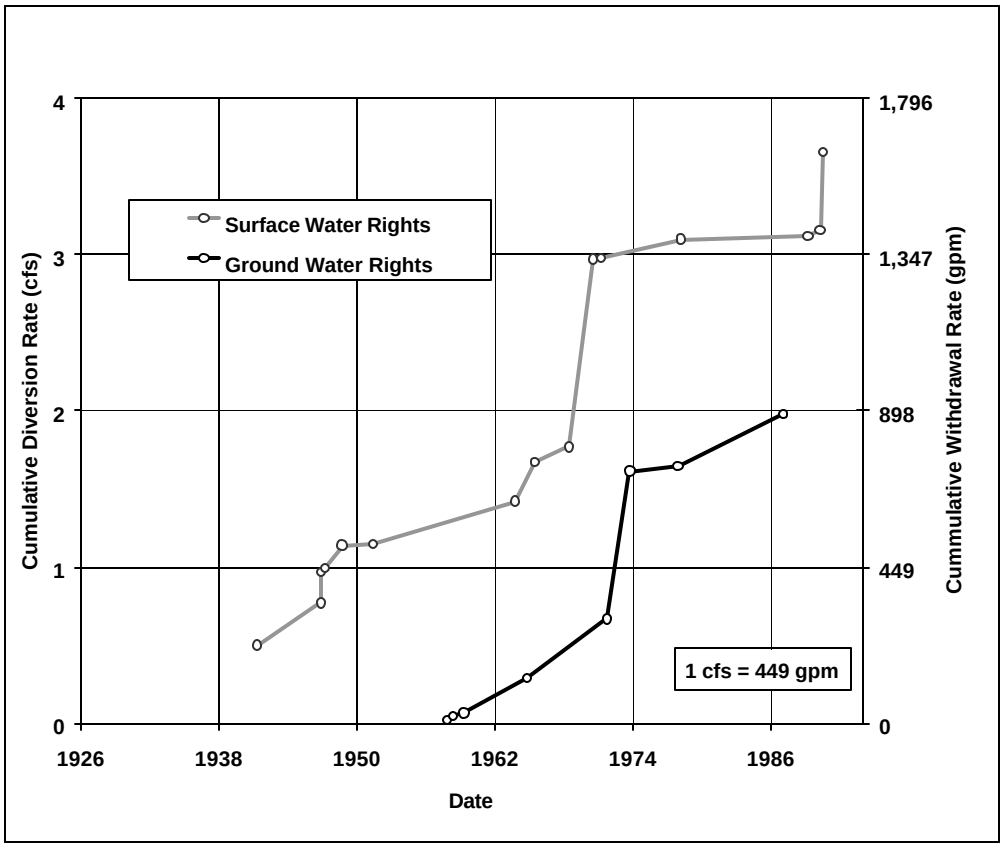


Figure 5.3-34: Toboton/Powell/Lackamus Subbasin – Water Allocated Over Time

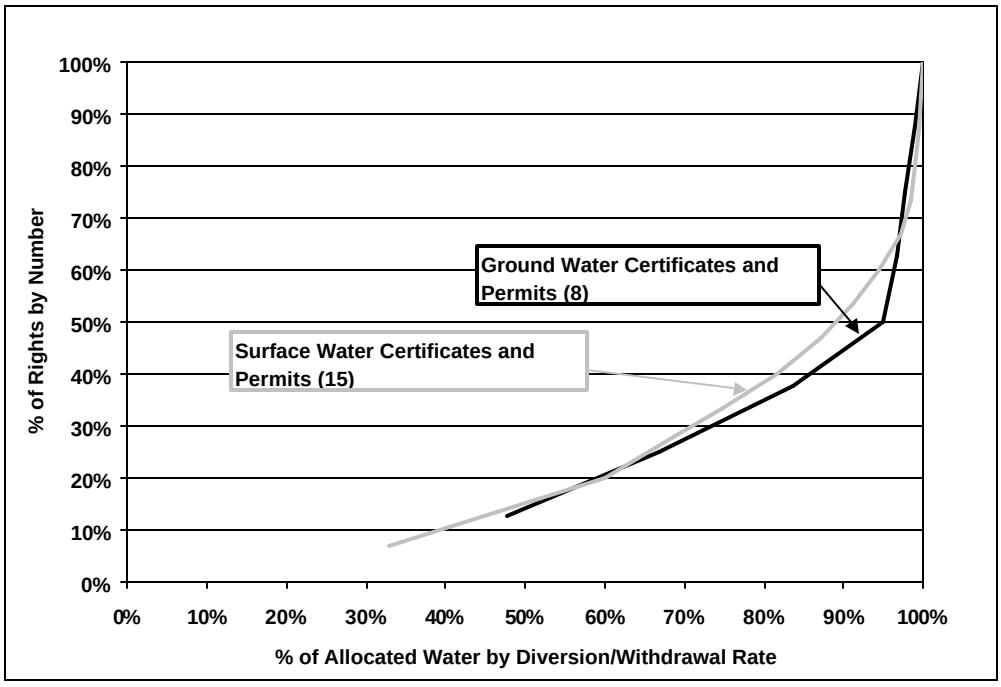


Figure 5.3-35: Toboton/Powell/Lackamus Subbasin – Percent of Rights Covering Percent of Allocated Water

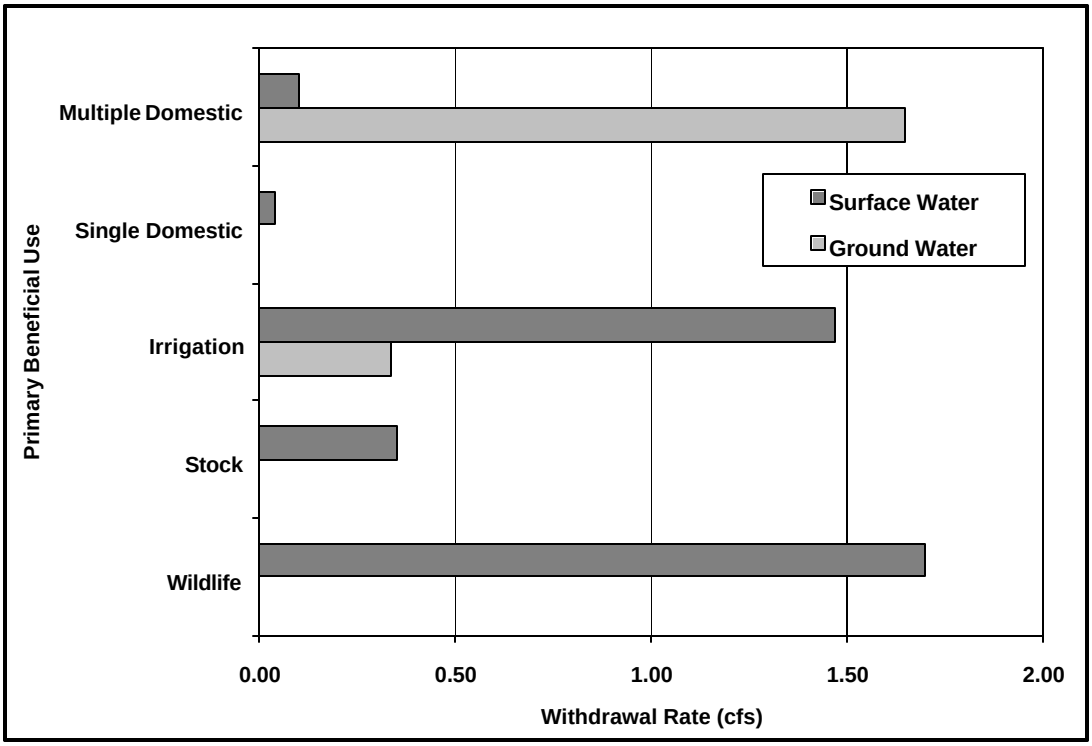


Figure 5.3-36: Toboton/Powell/Lackamus Subbasin – Allocated Diversion/Withdrawal Rate by Primary Beneficial Use (cfs)

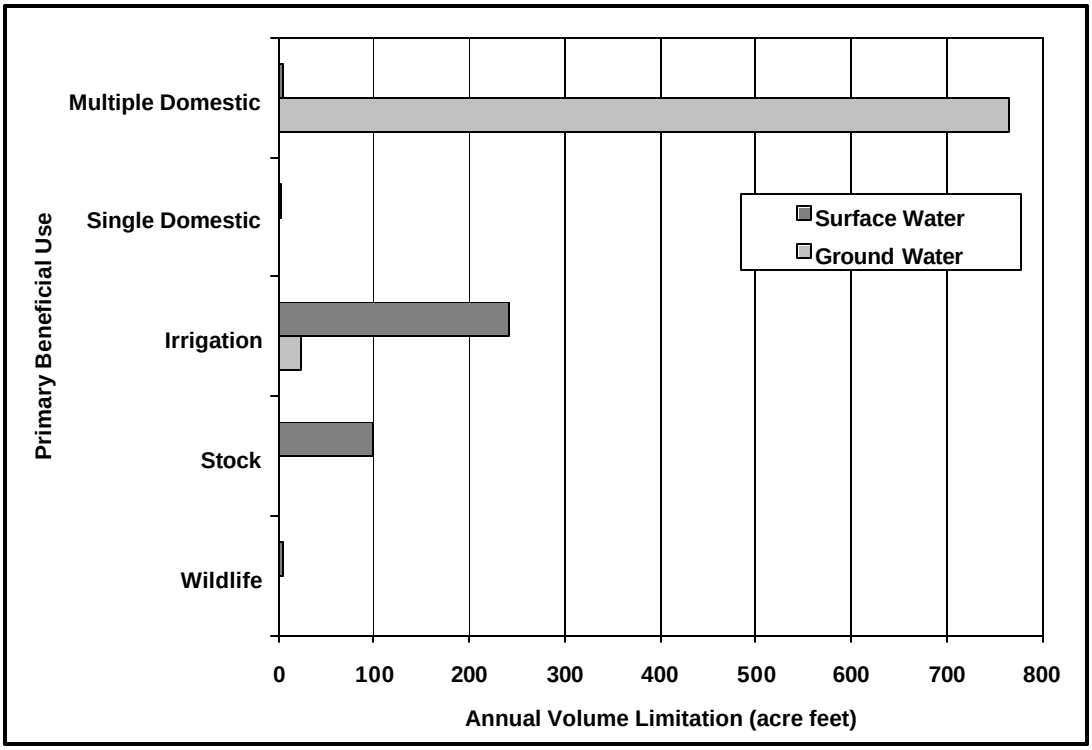


Figure 5.3-37: Toboton/Powell/Lackamus Subbasin – Allocated Volume by Primary Beneficial Use (acre-feet)

Water Use

Residential Water Use

The 2000 population in the Toboton/Powell/Lackamus Subbasin was 1,591, the lowest population of the six subbasins for the Lower Nisqually Basin (WRIA 11). The depletions from residential water use range from about 0.05 cfs in the winter to 0.22 cfs in the summer months; the demand ranges from 0.39 cfs to 0.77 cfs, respectively.

Public Water Systems

The Toboton/Powell/Lackamus subbasin is the source of water supply for seven public water systems serving 1,327 people. The five Group A Public Water Systems serve a population of 1,311 with 547 residential connections. In addition, there are 970 non-residential connections, resulting in a total of 1,516 connections. Clearwood was the largest public water system and as noted previously, holds one water right certificate for 529 acre-feet and has an application submitted for 1,000 gpm to serve 1,355 units.

Table 5.3-27: Toboton/Powell/Lackamus Subbasin – Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections
Clearwood	1161	484	871	1,355
Driftwood Valley Camp Assn	75	30	50	80
Single Tree Estates	62	24	18	42
Pack Forest	8	4	14	18
Camp Of The Cascades	5	5	16	21
Total	**1,311**	**547**	**969**	**1,516**

Source: Washington Department of Health, 2001

There are 2 Group B Public Water Systems, serving 16 people, 10 residential connections and 3 non-residential connections. The largest of the Group B systems serves 12 people with 6 residential connections.

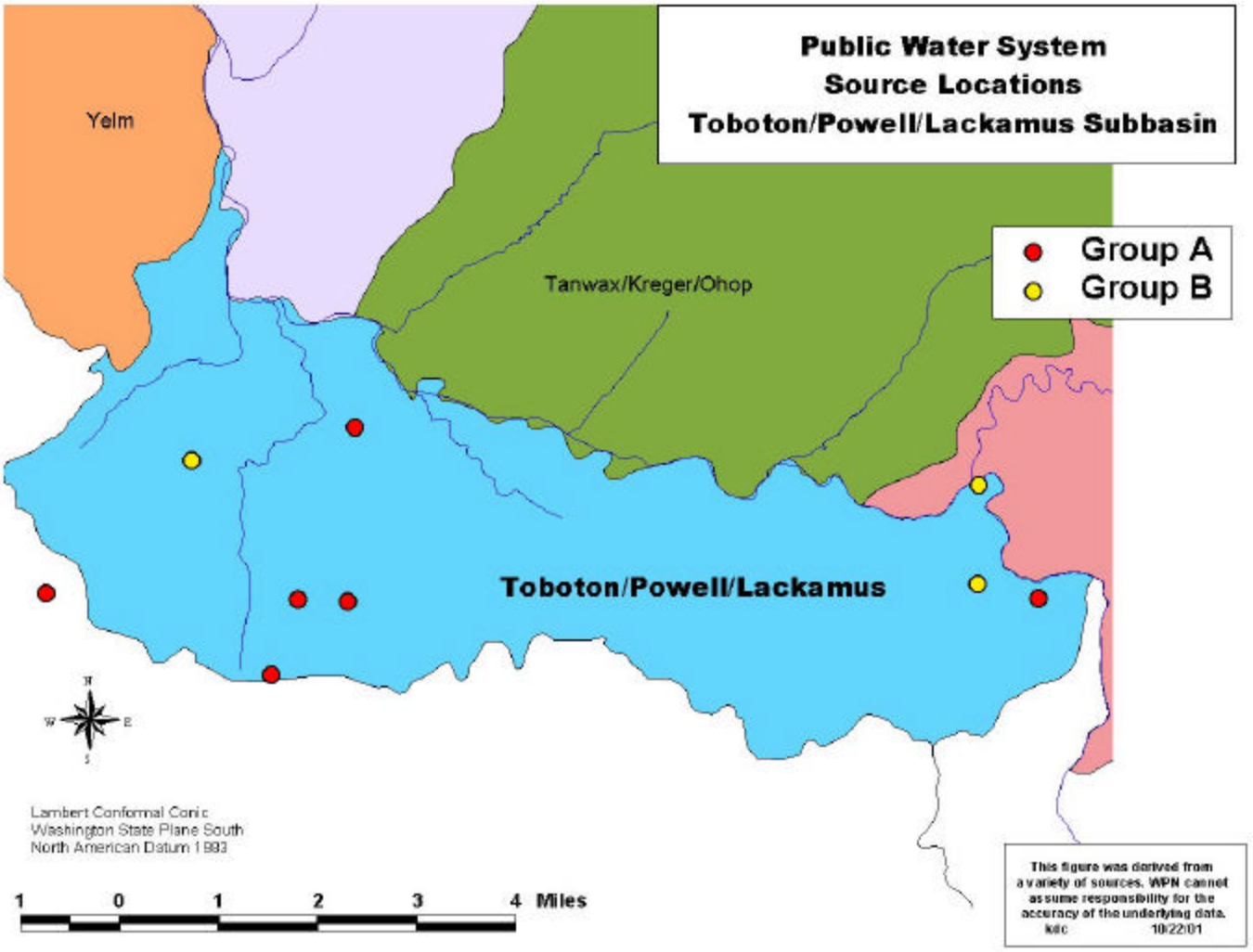


Figure 5.3-38: Toboton/Powell/Lackamus Subbasin – Public Water System Source Locations

Exempt Wells

From the difference between the total population and those served by public water systems and individual rights, about 240 people in the Toboton/Powell/Lackamus Subbasin are on exempt wells or under multiple domestic rights. There were nine multiple domestic rights and seven public water systems, therefore, two multiple domestic rights cover a small portion of the 240 people.

Comparison of Streamflow and Water Allocation

Comparison of the streamflow to allocated water in this subbasin shows less concern than other subbasins (Figure 5.3-38). The points of concern when considering the total water allocation occur in the months of July, August, and September. However, when investigating an estimate of depletions under the assumption that all ground withdrawals are 100% connected to the river, the net effect is minimal and less than the 90% exceedance flow level in all months. In addition, the streamflow in this subbasin reflects minimal use and, therefore, is more representative of natural flows in the subbasin.

Table 5.3-28: Toboton/Powell/Lackamus Subbasin - Water Right Depletions Based on Annual Volume Limits

Use Sector	Annual Limits (acre-feet)	Depletion Winter (acre-feet)	Depletion Winter (cfs)	Depletion Summer (acre-feet)	Depletion Summer (cfs)
Multiple domestic	769	33.0	0.08	144.3	0.475
Single Domestic	4	0.2	0.00	0.8	0.002
Irrigation	364	0	0.00	157	0.516
Municipal – (in-of-basin)	0	0.0	0.00	0.0	0.000
Municipal – (out-of-basin)	0	0	0.00	0	0.000
Stock 87% depletion	5	2.53	0.01	1.82	0.006
Other (Non-consumptive uses)	45	22.74	0.054	16.41	0.054
Total	**1,187**	**58**	**0.14**	**320**	**1.05**

Note: The values calculated in Table 5.3-28 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be reported as zero. Also keep in mind that in the case where more than one use was identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

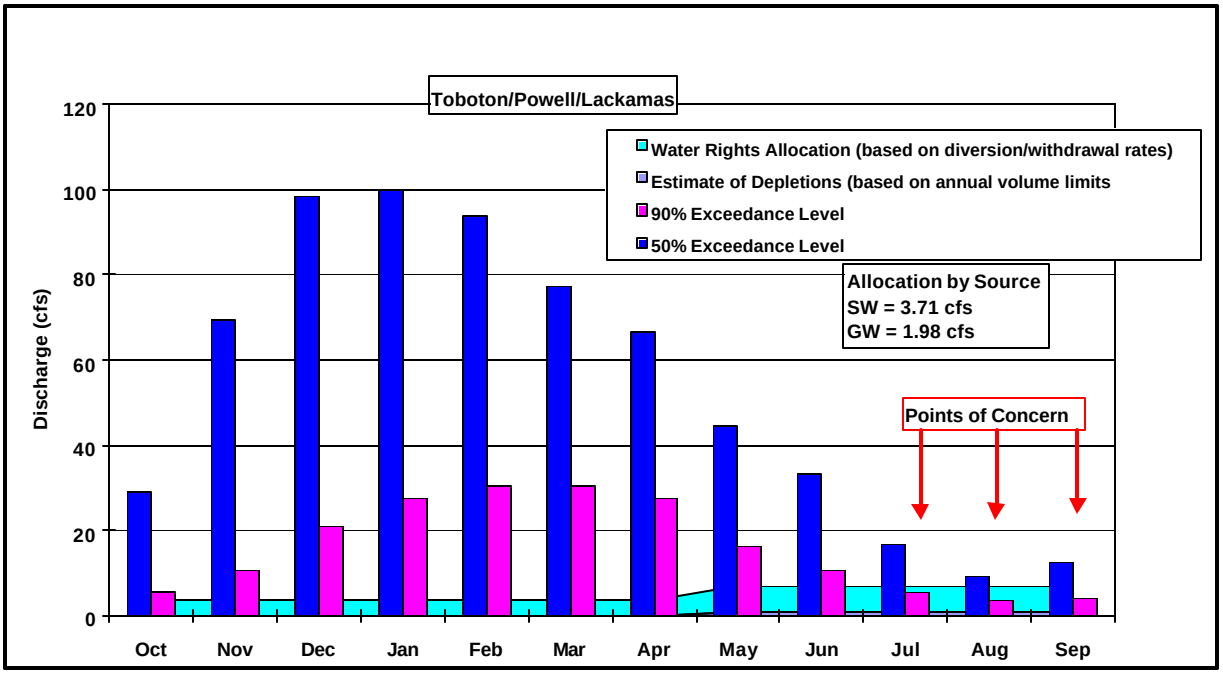


Figure 5.3-39: Toboton/Powell/Lackamus Subbasin – Streamflow vs. Water Allocation & Estimated Depletions to Water Rights

TANWAX/KREGER/OHOP

Water Rights

There were 157 water rights on file with WDOE in the Tanwax/Kreger/Ohop Subbasin (Ohop Subbasin); 16 of these are pending applications and 6 are permits. The total allocation under certificates and permits was 10.46 cfs for surface water and 918 gpm (2.04 cfs) for ground water (Table 5.3-29). The largest right in the basin is a surface water certificate for 2.40 cfs to irrigate 120 acres. The largest ground water right was a multiple domestic right for the Clear Lake Water District for 150 gpm and 59 acre-feet/year, which is the largest public water system in this subbasin.

The beneficial use sector with the highest volume of allocated water was irrigation; 679 acres and 1,257 acre-feet/year. There is a total of 1,553 acre-feet allocated per year for the entire subbasin. Irrigation represents 81% of this annual allocation. In fact, the five largest surface water rights are irrigation certificates for a combined rate of 5.1 cfs.

Surface water represents 87% of the total annual volume allocation. Of the surface water allocation rate, 29% covers 90% of the cumulative diversion rate and 66% of the ground water rights cover 90% of the allocated withdrawal rate (Figure 5.3-40).

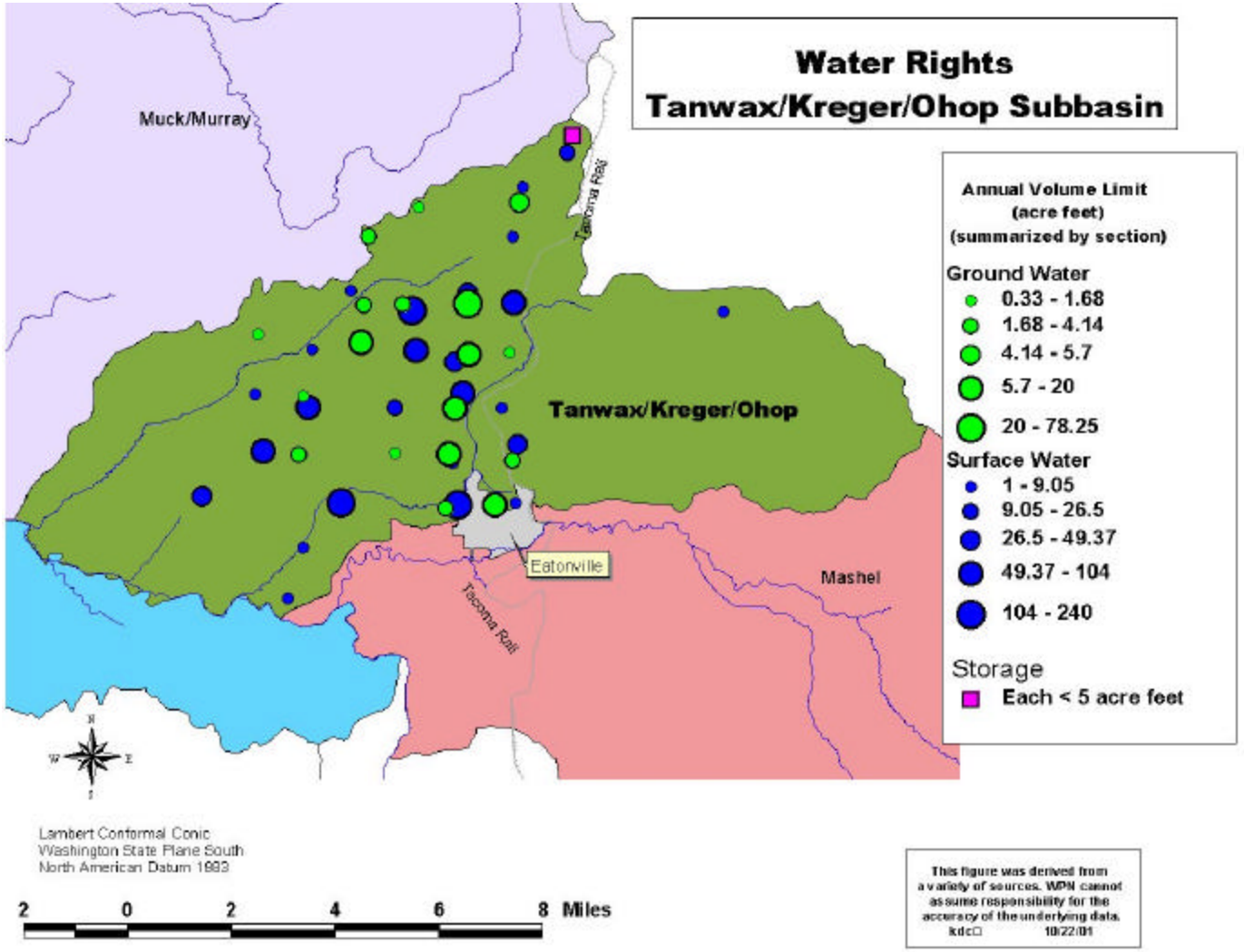


Figure 5.3-40: Tanwax/Kreger/Ohop Subbasin – Water Rights Summary by Volume (acre- feet)

Table 5.3-29: Tanwax/Kreger/Ohop Subbasin – Water Rights Summary of Certificates, Permits and, Applications

	All Certificates					Ground Water Certificates				Surface Water Certificates				Storage Certificates	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Commerical/Industrial	2	0.10	3	73		1	3	1		1	0.10	72			
General Domestic	1		60	20		1	60	20							
Multiple Domestic	20	0.24	445	119		11	445	107		9	0.24	12			
Single Domestic	59	0.70	118	36		11	118	8		48	0.70	28			
Fire Protection	3	0.16	20	18		1	20	10		2	0.16	8			
Fish Propagation	4	0.37	0	5						4	0.37	5			
Irrigation	30	8.43	75	1,216	657	3	75	26	22	27	8.43	1,191	635		
Rail Way	1	0.08								1	0.08				
Stock	13	0.33	70	38	12	4	70	10	1	9	0.33	28	11		
Wildlife	2			7	5									2	7
Totals	**135**	**10.41**	**791**	**1,532**	**674**	**32**	**791**	**181**	**23**	**101**	**10.41**	**1,344**	**646**	**2**	**7**

	All Permits					Ground Water Permits				Surface Water Permits				Storage Permits	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Multiple Domestic	2		77	9		2	77	9							
Single Domestic	3	0.05		2						3	0.05	2			
Irrigation	1		50	10	5	1	50	10	5						
Totals	**6**	**0.05**	**127**	**21**	**5**	**3**	**127**	**19**	**5**	**3**	**0.05**	**2**	**0**	**0**	**0**

	All Applications					Ground Water Applications				Surface Water Applications				Storage Applications	
Primary Beneficial Use	# rights	Instantaneous Flow Rates cfs	gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate gpm	Annual Volume Limit af	Potentially Irrigated acres	# rights	Instantaneous Flow Rate cfs	Annual Volume Limit af	Potentially Irrigated acres	# rights	Annual Volume Limit af
Multiple Domestic	6	0.18	378			5	378			1	0.18				
Single Domestic	2	0.02	10			1	10			1	0.02				
Irrigation	6	3.02	250		109	3	250		89	3	3.02		20		
Power	1	0.04								1	0.04				
Stock	1		100			1	100								
Totals	**16**	**3.26**	**738**	**0**	**109**	**10**	**738**	**0**	**89**	**6**	**3.26**	**0**	**20**	**0**	**0**

TOTAL:	**157**	**13.72**	**1,656**	**1,553**	**788**	**45**	**1,656**	**200**	**117**	**110**	**13.72**	**1,346**	**666**	**2**	**7**

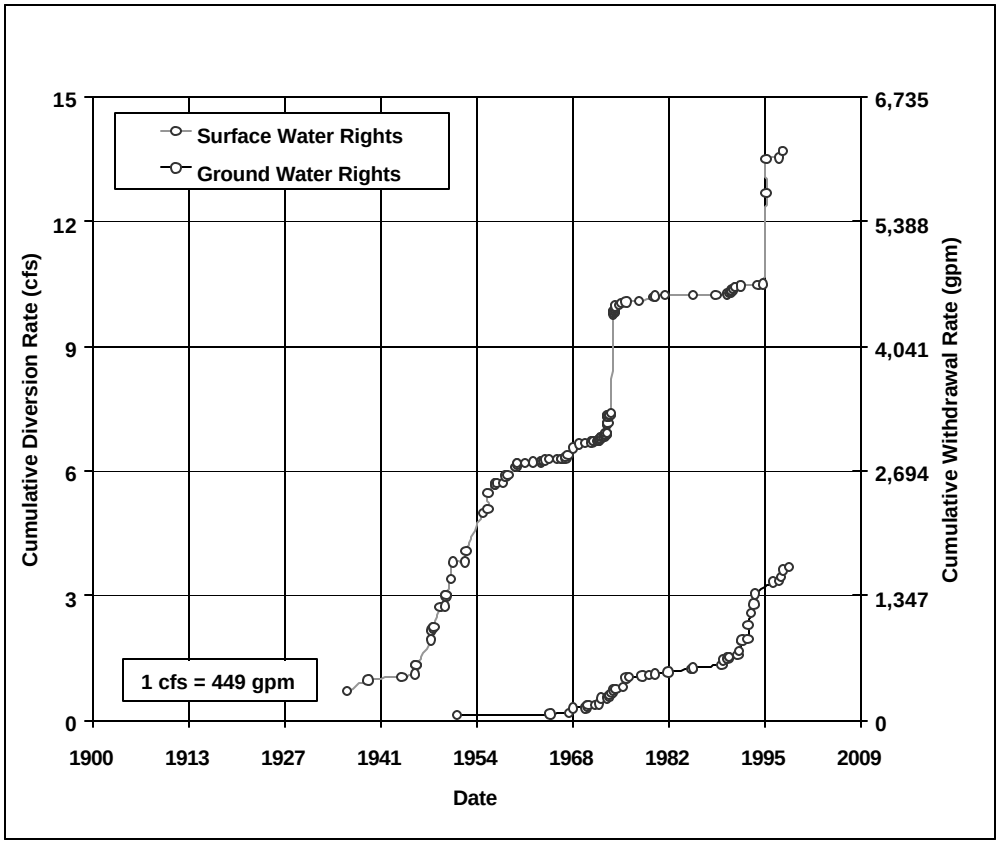


Figure 5.3-41: Tanwax/Kreger/Ohop Subbasin – Water Allocated Over Time

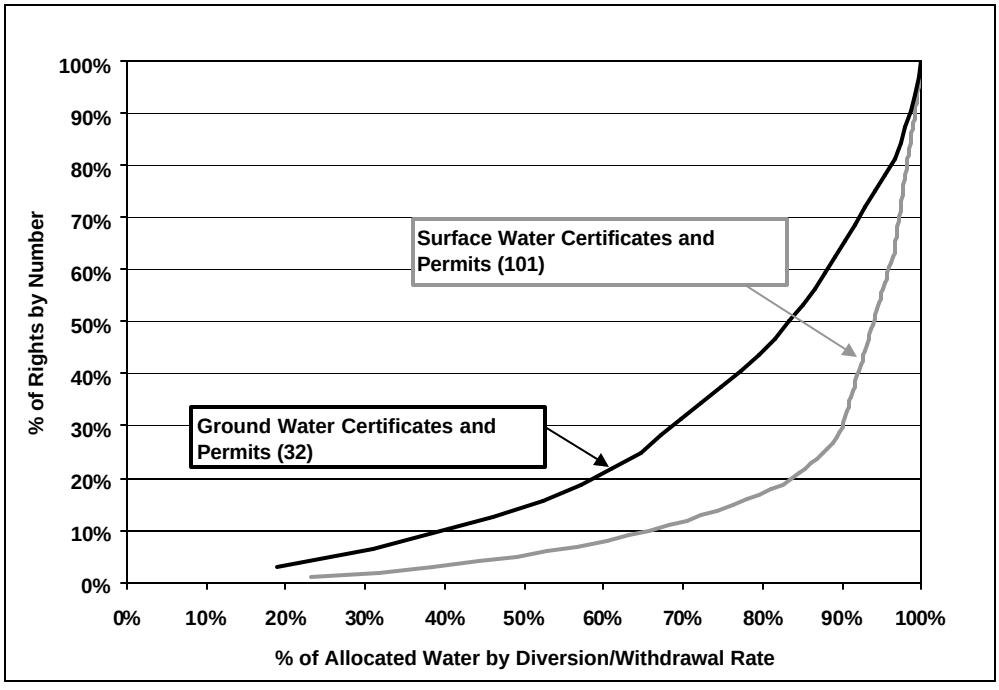
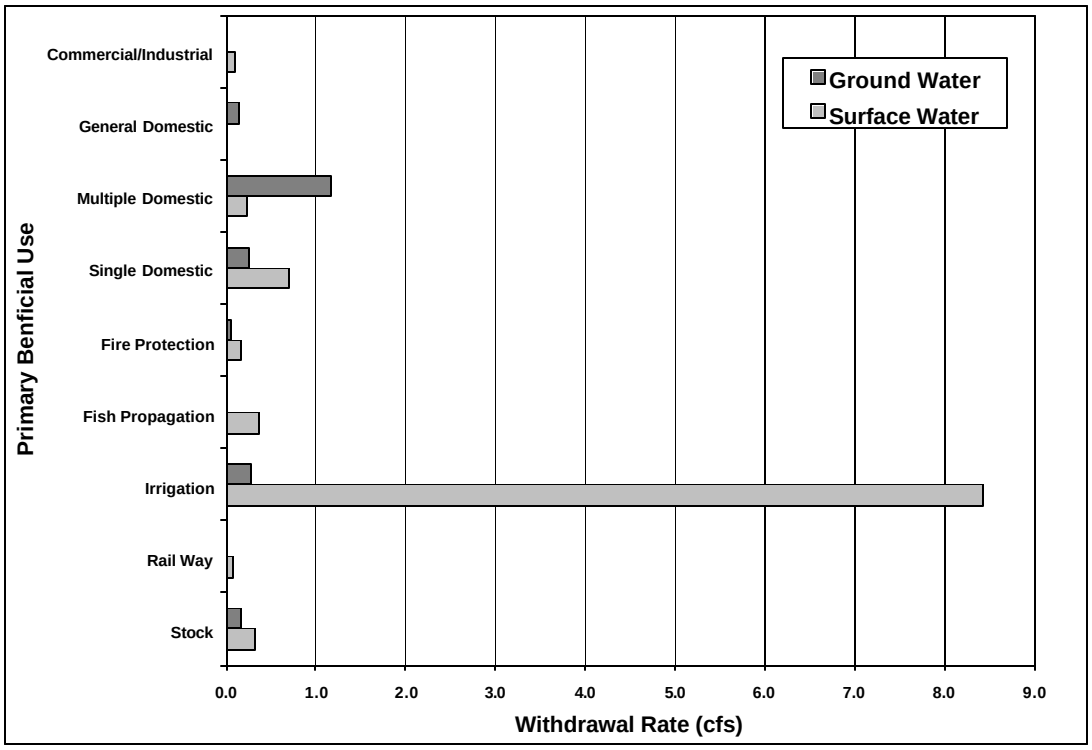


Figure 5.3-42: Tanwax/Kreger/Ohop Subbasin – Percent of Rights Covering Percent Allocated Water



igure 5.3-43: Tanwax/Kreger/Ohop Subbasin – Allocated Diversion/Withdrawal Rate by Primary Beneficial Use (cfs)

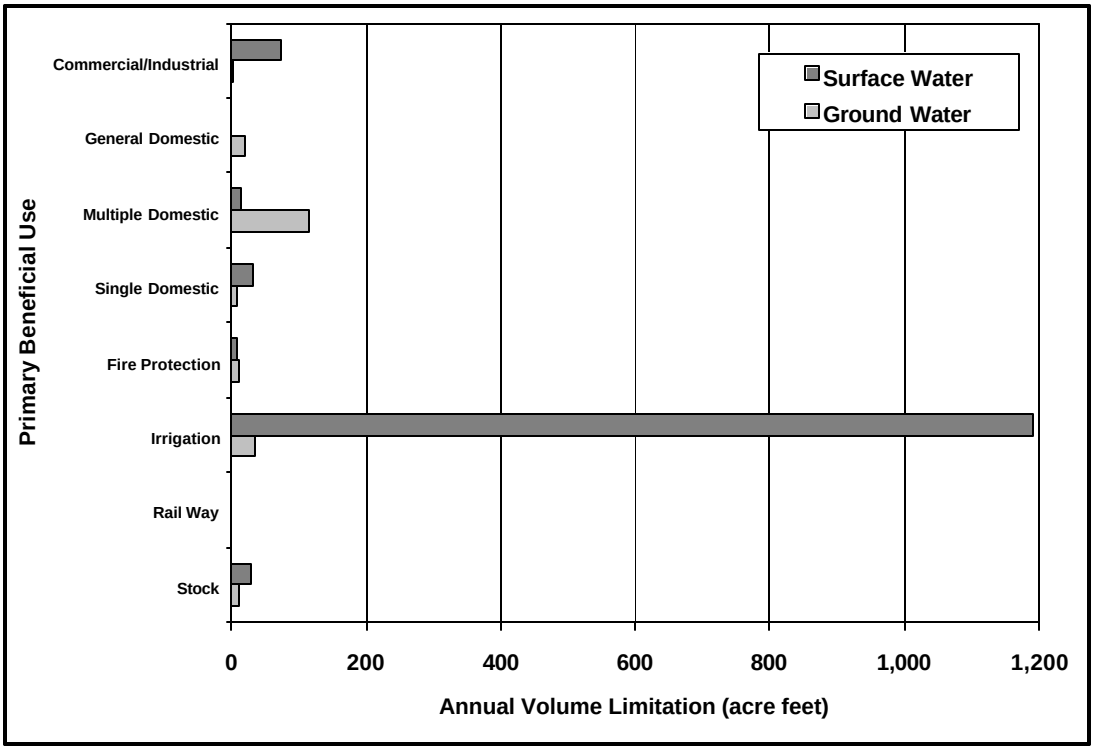


Figure 5.3-44: Tanwax/Kreger/Ohop Subbasin – Allocated Volume by Primary Beneficial Use (acre-feet)

Water Use

Residential Water Use

The total population in the Tanwax/Kreger/Ohop Subbasin for 2000 was 4,571. Applying the 143 gcd in winter and the 286 gcd in summer, the water demand was estimated to be 1.01 cfs and 2.02 cfs, respectively. The net effect on the water resources was roughly 0.13 cfs and 0.57 cfs, respectively.

Public Water Systems

The Tanwax/Kreger/Ohop subbasin is the source of water supply for 61 public water systems serving 972 people. Of these, there are 11 Group A Public Water Systems that serve a total population of 418, and 151 residential connections (average of 2.77 people per household). In addition, there are 143 non-residential connections, resulting in a total of 294 connections. The largest five Group A systems represent 97% of the population and 97% of the residential connections served by this classification of public water systems (Table 5.3-30).

Northwest Trek Wildlife Park in the Clear Lake Area serves about 160,000-200,000 people a year. The Park has a 600' deep well that supplies drinking water and the Park pumps water from Horseshoe Lake to various exhibits. This public water system was included in the Group A category and reported a population of two with one residential and one non-residential connection.

Table 5.3-30: Tanwax/Kreger/Ohop Subbasin – Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections
Clear Lake Water District	233	105	0	105
Boots & Saddles Water Co	150	34	0	34
Hope International #3 Water System	9	3	2	5
Camp Arnold	8	3	21	24
Camp Benbow	5	2	59	61
Total	**405**	**147**	**82**	**229**

Source: Washington Department of Health, 2001

There are 50 Group B Public Water Systems serving 554 people with 206 residential connections. There were an additional 214 non-residential connections. The average number of people per household for this classification is 2.69. The three largest Group B systems each serve 23 people with 9 residential connections.

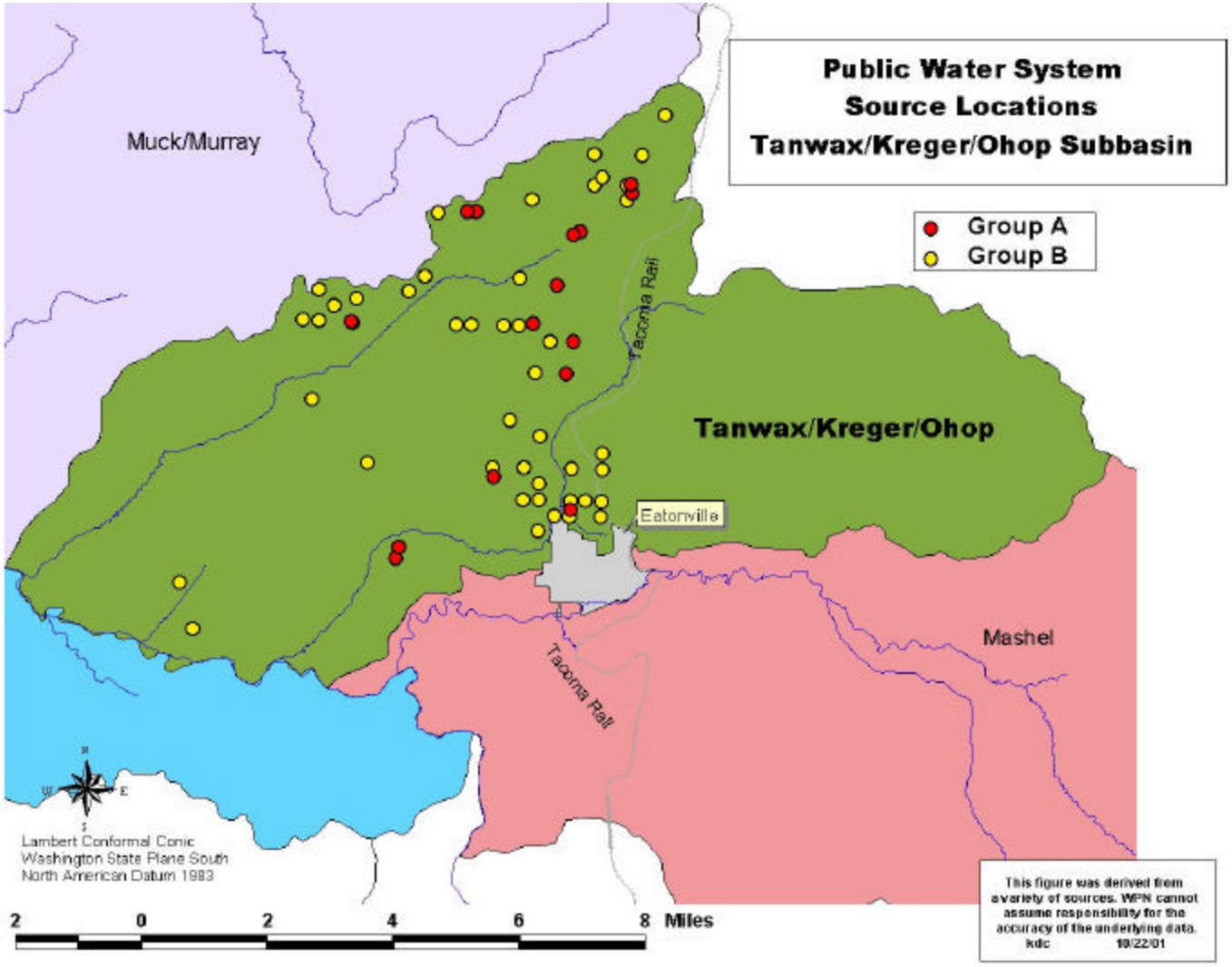


Figure 5.3-45: Tanwax/Kreger/Ohop Subbasin – Public Water System Source Locations

Exempt Wells

Of the 4,571 people estimated to reside in the subbasin, only 21% (972 people) are supplied water through a public water system. There were 62 single domestic rights that cover roughly 160 people, leaving those under exempt wells and/or multiple domestic rights to 3,429 people. There were 20 multiple domestic rights to cover 61 public water systems which implies that a good portion of the public water systems are also using wells without the benefit of a water right. To understand which public water systems do not have water rights, a survey of the systems can be done in conjunction with cross-referencing the water rights database with the public water system database. Public water systems can withdraw water under the exempt well statute so long as 5,000 gallons per day and up to 0.5 acres of irrigation is not exceeded. The maximum number of homes that could be served if the entire 5,000 gallons per day (5.6 acre-feet) were used is 6.

Comparison of Streamflow and Water Allocation

By examination of comparison of streamflow to water rights allocation and estimated depletions (Figure 5.3-45), the depletions in this subbasin have a minor effect on the surface water system. In addition, the streamflow in this subbasin more closely approximates natural flow than in other subbasin since the use from the system is minor.

Table 5.3-31: Tanwax/Kreger/Ohop Subbasin - Water Right Depletions Based on Annual Volume Limits

Use Sector	Annual Limits (acre-feet)	Depletion Winter (acre-feet)	Depletion Winter (cfs)	Depletion Summer (acre-feet)	Depletion Summer (cfs)
Commercial[1]	73	4.8	0.01	9.8	0.032
Multiple domestic	148	6.3	0.02	27.8	0.091
Single Domestic	38	1.6	0.00	7.1	0.023
Irrigation	1,259	0	0.00	541	1.784
Municipal – (in-of-basin)	0	0.0	0.00	0.0	0.000
Municipal – (out-of-basin)	0	0	0.00	0	0.000
Stock 87% depletion	14	7.07	0.02	5.11	0.017
Other (non-consumptive)	21	0	0.00	0	0
Total	**1,553**	**15**	**0.04**	**581**	**1.92**

[1]Solly et.al., 1993 *Winter* = October through April, *Summer* = May through September

Note: The values calculated in Table 5.3-31 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be

reported as zero. Also keep in mind that in the case where more than one use was identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

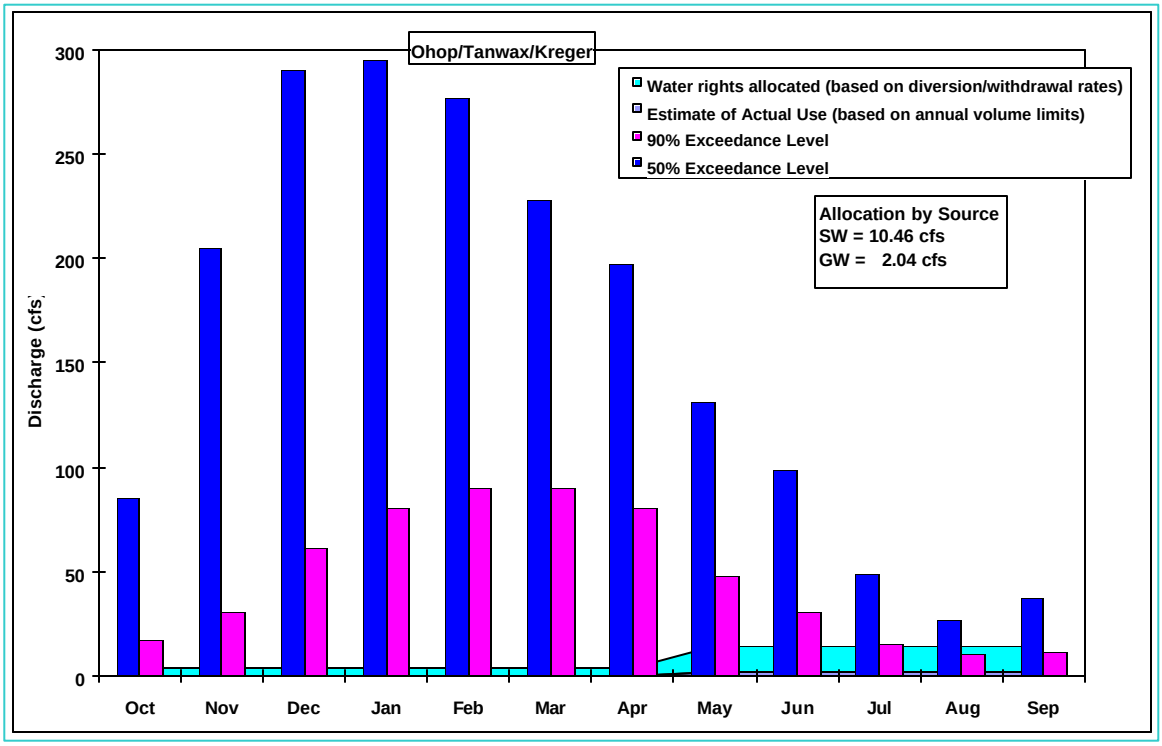


Figure 5.3-46: Tanwax/Kreger/Ohop Subbasin – Streamflow vs. Water Allocation & Estimated Depletion to Water Rights

MASHEL

Water Rights

Mashel Subbasin has a total of 43 rights, of the Lower Nisqually Subbasins only the Toboton/Powell/Lackamus Subbasin has fewer. Since this subbasin is primarily forested, the water use is relatively low here.

There were potentially 175 acres irrigated in this subbasin by 9 different surface water rights; there was one ground water irrigation right. In addition, there were 22

rights for each of the two categories of multiple and single domestic use covering 635 acre-feet. Six of the multiple domestic rights use ground water as their source of supply.

Tacoma City Light possesses three multiple domestic surface water rights to supply water to the community of LaGrande; the total diversion rate is 0.08 cfs (8 acre-feet annually). The Town of Eatonville holds the largest surface water right for 2.3 cfs.

Ninety percent of the allocated withdrawals/diversions are accounted for in 35% of surface water rights and 50% of the ground water diversions. By volume, most of the allocations are from surface water sources and most of the consumptive uses are associated with municipal/domestic and irrigation water use (Figures 48-50).

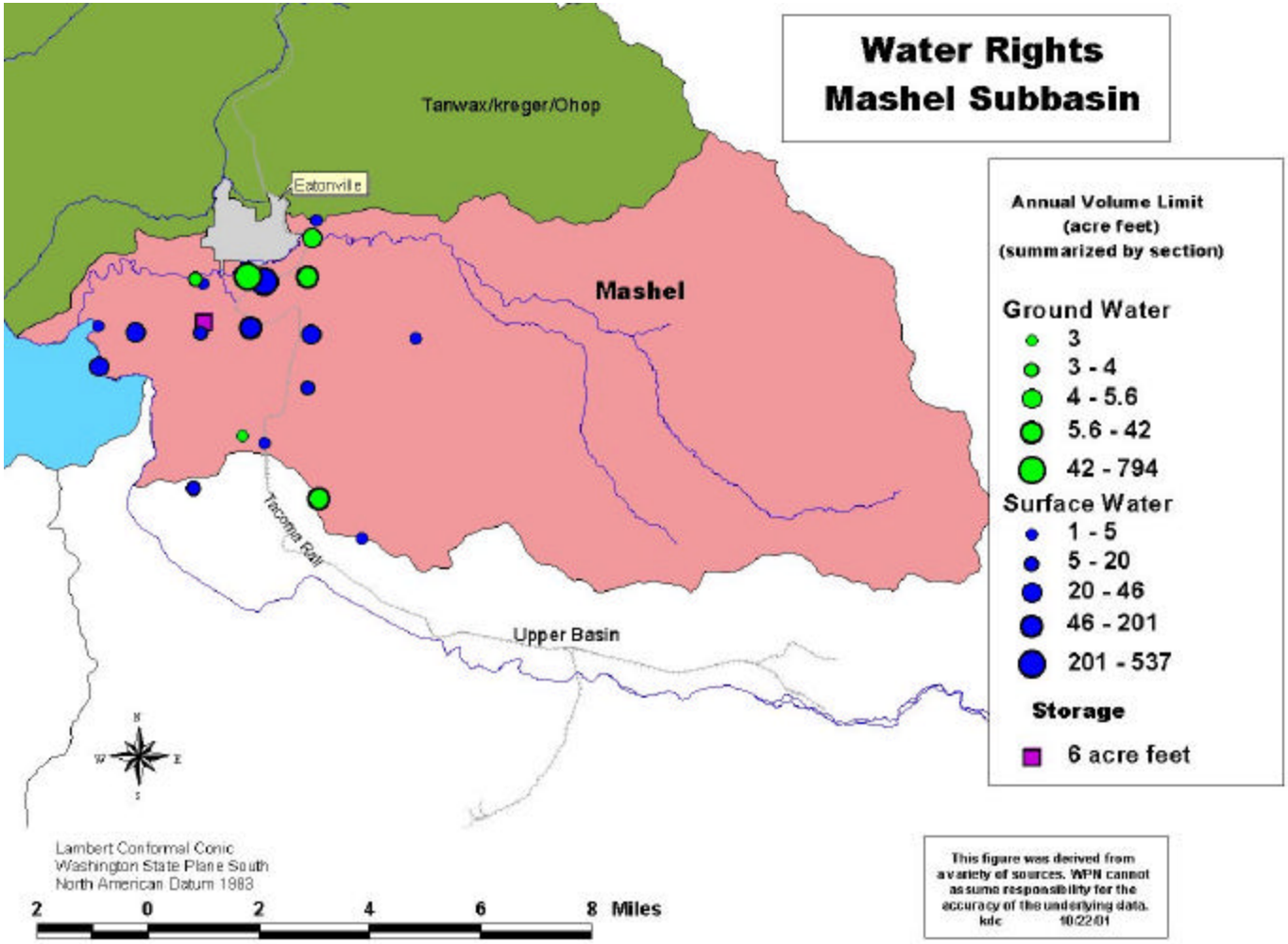


Figure 5.3-47: Mashel Subbasin - Water Rights Summary by Volume (acre - feet)

Table 5.3-32: Mashel Subbasin – Water Rights Summary of Certificates, Permits, and Applications

Primary Beneficial Use	All Certificates					Ground Water Certificates				Surface Water Certificates				Storage Certificates	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Multiple Domestic	11	2.55	119	620	0	5	119	52	0	6	2.55	568	0		
Single Domestic	10	0.16		10	0					10	0.16	10	0		
Fire Protection	3	0.27		17	0					2	0.27	11	0	1	6
Irrigation	10	1.83	30	344	175	1	30	21	10	9	1.83	323	165		
Municipal	2		610	528	0	2	610	525	0						
Rail Way	1	0.06		0	0					1	0.06	0	0		
Stock	3	0.12	17	7	0	1	17	3	0	2	0.12	4	0		
Totals:	**40**	**4.99**	**776**	**1,524**	**175**	**9**	**776**	**601**	**10**	**30**	**4.99**	**915**	**165**	**1**	**6**

Primary Beneficial Use	All Permits					Ground Water Permits				Surface Water Permits				Storage Permits	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Multiple Domestic	1		40	5		1	40	5							
Fish Propagation	1	0.05								1	0.05				
Totals:	**2**	**0.05**	**40**	**5**	**0**	**1**	**40**	**5**	**0**	**1**	**0.05**	**0**	**0**	**0**	**0**

Primary Beneficial Uses	All Applications					Ground Water Applications				Surface Water Applications				Storage Applications	
		Instantaneous Flow Rates		Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Instantaneous Flow Rate	Annual Volume Limit	Potentially Irrigated		Annual Volume Limit
	# rights	cfs	gpm	af	acres	# rights	gpm	af	acres	# rights	cfs	af	acres	# rights	af
Power	1	0.40								1	0.40				
Totals:	**1**	**0.40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0.40**	**0**	**0**	**0**	**0**

TOTAL:	**43**	**5.44**	**816**	**1,529**	**175**	**10**	**816**	**605**	**10**	**32**	**5.44**	**915**	**165**	**1**	**6**

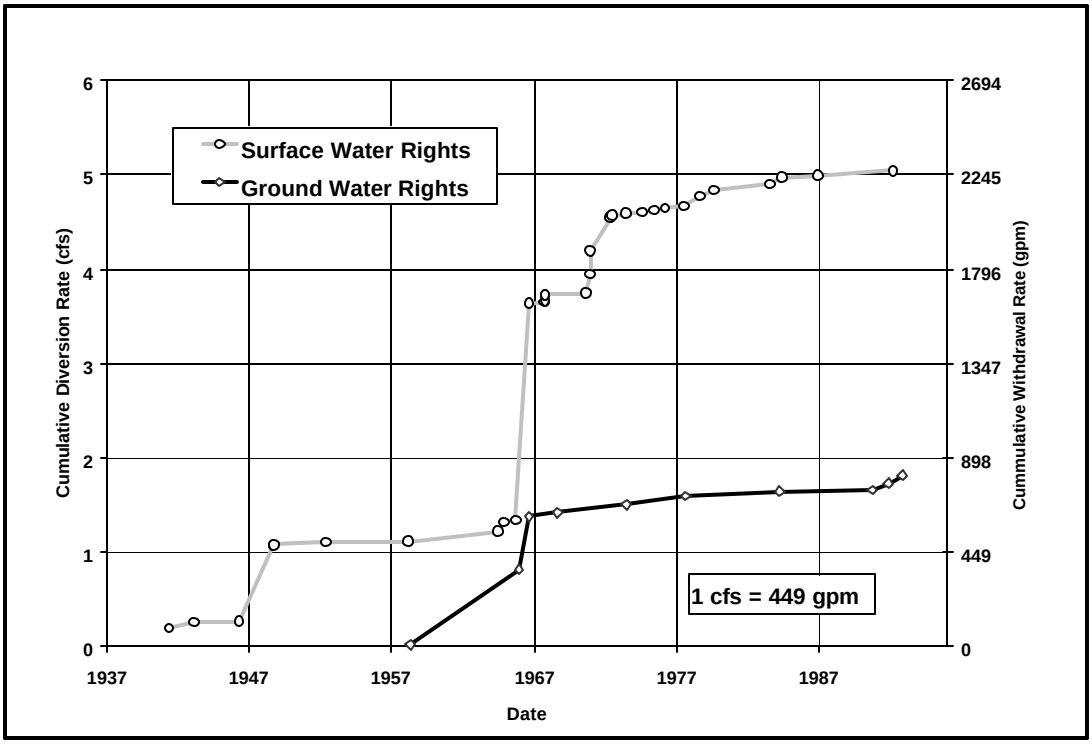


Figure 5.3-48: Mashel Subbasin – Water Allocated Over Time

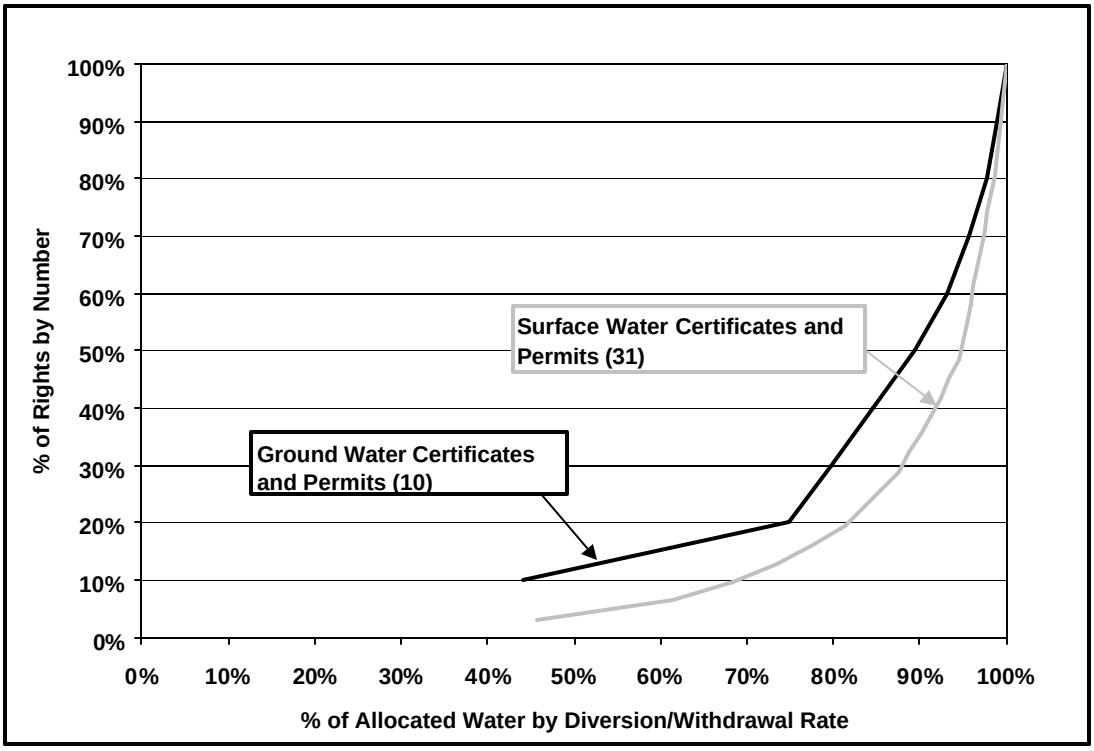


Figure 5.3-49: Mashel Subbasin – Percent of Rights Covering Percent Allocated Water

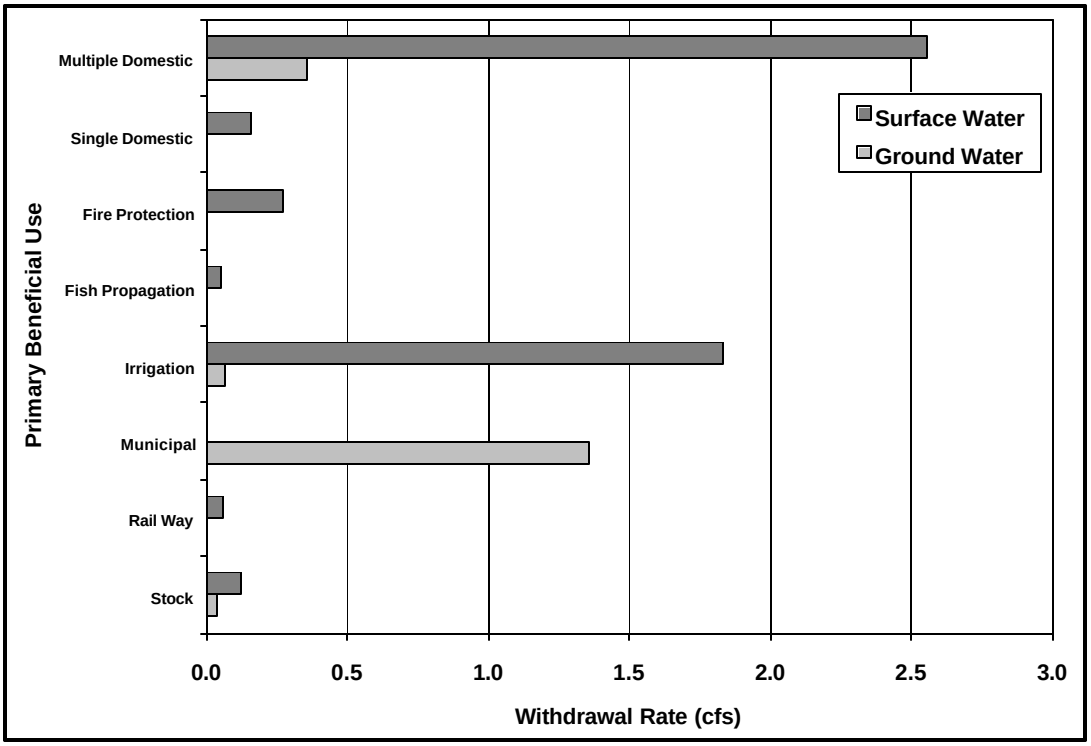


Figure 5.3-50: Mashel Subbasin – Allocated Diversion/Withdrawal Rate by Primary Beneficial Use (cfs)

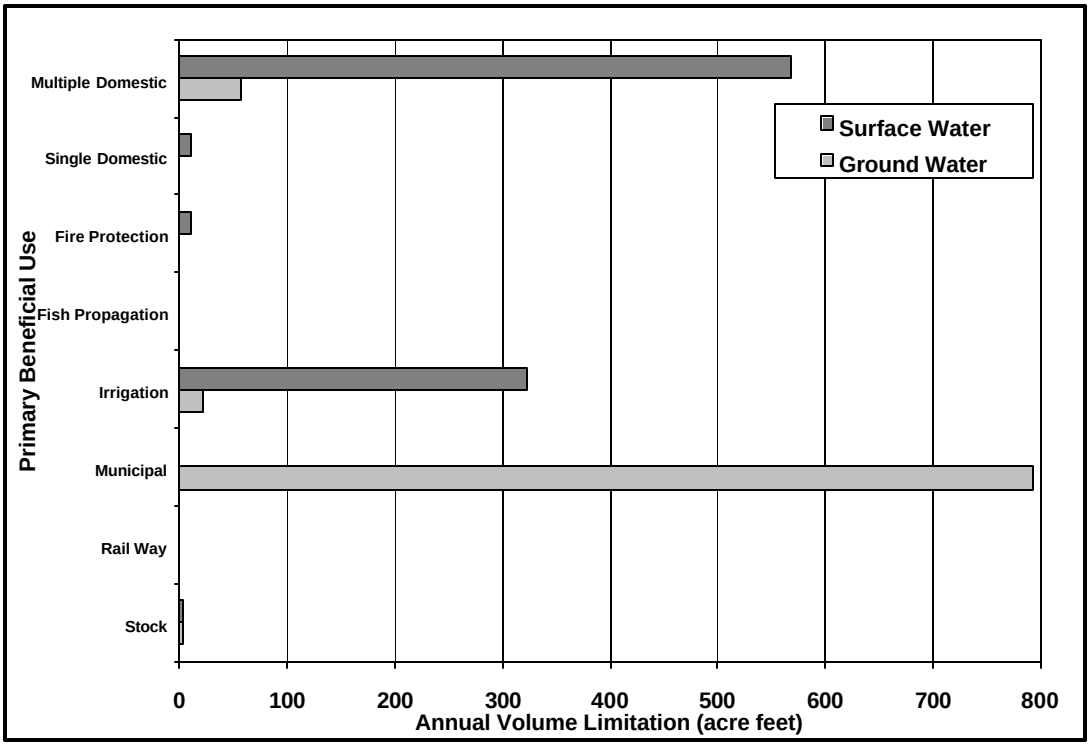


Figure 5.3-51: Mashel Subbasin – Allocated Volume Limits by Primary Beneficial Use (acre-feet)

Water Use

Residential Water Use

Based on the WDOH (1999) demand equation, the average per capita water demand was 119 gallons per day. With the estimated 2000 Mashel population of 2,279, the average total demand was 0.42 cfs. Net depletions were small at 0.05 cfs. The summer season demand was 0.84 cfs with depletions estimated at 0.24 cfs.

Public Water Systems

The Mashel subbasin is the source of water supply for 8 public water systems serving a total of 2,162. Of these, there are 2 Group A Public Water Systems that serve a total population of 2,095 and 795 residential connections. In addition, there are 123 non-residential connections, resulting in a total of 918 connections (Table 5.3-33).

Table 5.3-33: Mashel Subbasin – Largest Group A Public Water Systems

Public Water System	Population	Residential Connections	Non-Residential Connections	Total Connections
Town of Eatonville	1,915	735	123	858
Holiday Hills Community Club Inc	180	60	0	60
Total	**2,095**	**795**	**123**	**918**

Source: Washington Department of Health, 2001

There are 6 Group B Public Water Systems, serving 67 people with 24 residential connections and 0 non-residential connections. The largest of the Group B systems serves 22 people with 8 residential connections.

The Town of Eatonville straddles the boundary between the Mashel and Ohop Subbasins; however, the source of supply location for the Town is in the Mashel Subbasin according to the WDOH Public Water System Database. The Town holds three water rights, one surface water right (2.3 cfs and 525 acre-feet) and two ground water rights (610 gpm and 794 acre-feet). The ground water rights are supplemental to the surface water right, consequently the total combined annual volume of water that can be withdrawn from the system is 525 acre-feet (Gray & Osborne, Inc., 1996).

Pack Forest, a University of Washington experimental forest, is also located within Mashel Subbasin. There are two community domestic water rights for the facility to supply roughly 100 people per day. The assumed per capita usage noted in the water rights was 125 gallons; the annual volume limit was 19 acre-feet.

Exempt Wells

Of the total subbasin population, roughly 95% are served by a public water system, most of whom reside within the Town of Eatonville. There were ten single domestic rights, which represent ten homes or 26 people. Consequently, there were about 90 people that used water under a multiple domestic right or an exempt well. If eight of the ten multiple domestic water rights are associated with the eight public water systems, then there would remain two multiple domestic rights that would cover a portion of the 90 people, the remainder would be served by exempt wells.

Comparison of Streamflow and Allocated Water

Comparison of streamflow to allocated water for the Mashel subbasin includes the instream flows set for Mashel River at river mile 3.25 (Figure 5.3-52). For this subbasin, the total demand on the surface water system is represented by the combination of the allocated uses and the instream flow. The estimated depletions to the system are small when compared to instream flow. The graph indicates that the combination of instream flow and depletions exceeds the 90% streamflow during the months of June through November. At the 50% exceedance level, allocated water plus instream flows only exceeds streamflow in the month of August.

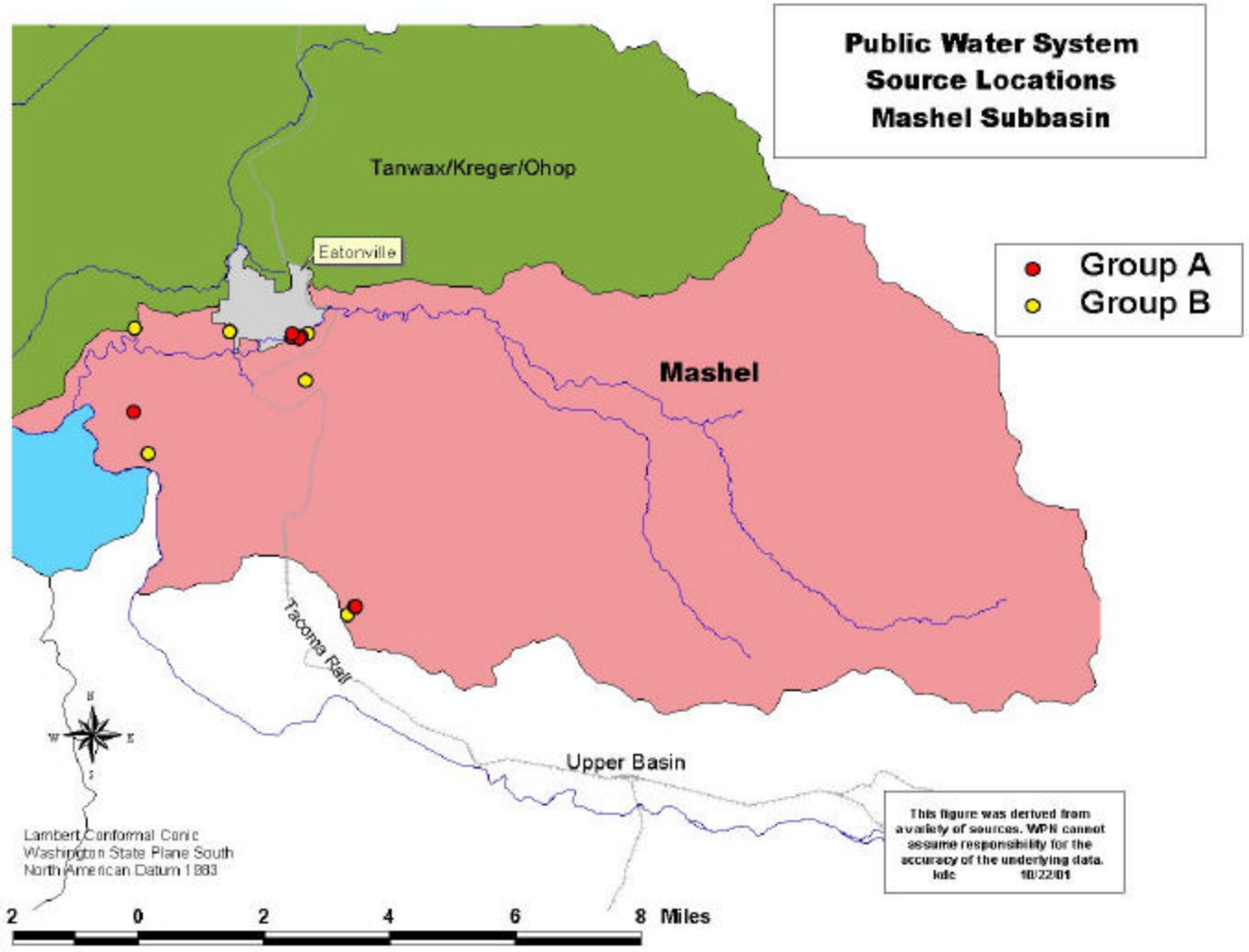


Figure 5.3-52: Mashel Subbasin – Public Water Systems Source Locations

Table 5.3-34: Mashel Subbasin - Water Right Depletions Based on Annual Volume Limits

Use Sector	Annual Limits (acre-feet)	Depletion Winter (acre-feet)	Depletion Winter (cfs)	Depletion Summer (acre-feet)	Depletion Summer (cfs)
Multiple domestic	625	26.8	0.064	105.0	0.35
Single Domestic	10	0.4	0.001	1.7	0.01
Irrigation	344	0.0	0.000	147.9	0.49
Municipal – (in-of-basin)	528	22.7	0.054	88.7	0.29
Stock 87% depletion	7	3.5	0.008	2.6	0.01
Other (non-consumptive)	17	0.0	0.000	0.0	0.00
Total	**1,531**	**53.4**	**0.127**	**346**	**1.14**

[1]Solley and others, 1993 Winter = October through April, Summer = May through September

Note: The values calculated in Table 5.3-34 are not carried to the 3rd or 4th decimal place to represent accuracy but as a means of expressing the magnitude of the effect of depletions. If these values were reported to the nearest tenth of a cfs, most would be reported as zero. Also keep in mind that in the case where more than one use was identified with a right the volume limitations were allocated according to the assumptions stated earlier in this document. Lack of sufficient information for each use resulted in a crude analysis to offer some perspective on the magnitude of depletions and should not be misconstrued as entirely accurate.

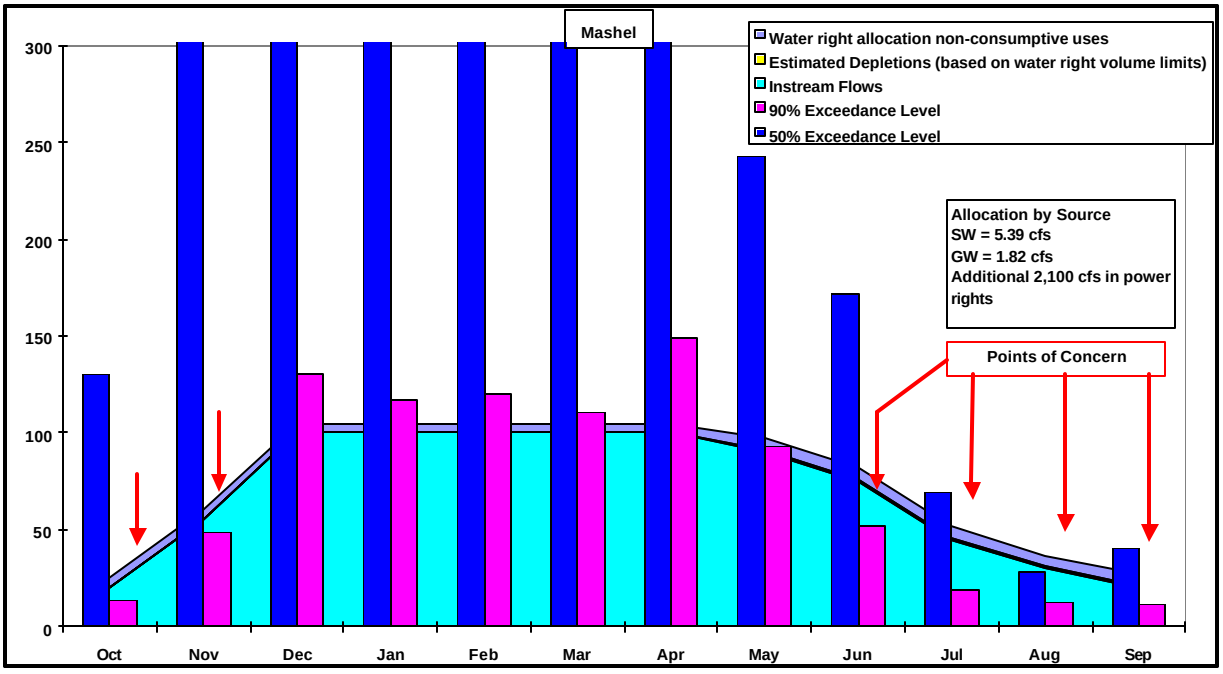


Figure 5.3-53: Mashel Subbasin – Streamflow vs. Water Allocated & Estimated Depletion from Water Rights